Subject information in this book is accurate as of June 1, 2009. Updated information is available at http://student.mit.edu/catalog/index.cgi.
Nondiscrimination Policy
The Massachusetts Institute of Technology is committed to the principle of equal opportunity in education and employment. The Institute does not discriminate against individuals on the basis of race, color, sex, sexual orientation, gender identity, religion, disability, age, veteran status, ancestry, or national or ethnic origin in the administration of its educational policies, admissions policies, employment policies, scholarship and loan programs, and other Institute administered programs and activities, but may favor US citizens or residents in admissions and financial aid.*

The Vice President for Human Resources is designated as the Institute’s Equal Opportunity Officer and Title IX Coordinator. Inquiries concerning the Institute’s policies, compliance with applicable laws, statutes, and regulations (such as Title VI, Title IX, and Section 504), and complaints may be directed to the Vice President for Human Resources, Room E19-215, 617-253-6512, or to the Coordinator of Staff Diversity Initiatives/Affirmative Action, Room E19-215, 617-253-1594. In the absence of the Vice President for Human Resources or the Coordinator of Staff Diversity Initiatives/Affirmative Action, inquiries or complaints may be directed to the Executive Vice President, Room 3-211, 617-253-3928, or to the Director of Labor and Employee Relations, Room E19-235N, 617-253-4264, respectively. Inquiries about the laws and about compliance may also be directed to the Assistant Secretary for Civil Rights, US Department of Education.

*The ROTC programs at MIT are operated under Department of Defense (DOD) policies and regulations, and do not comply fully with MIT’s policy of nondiscrimination with regard to sexual orientation. MIT continues to advocate for a change in DOD policies and regulations concerning sexual orientation, and will replace scholarships of students who lose ROTC financial aid because of these DOD policies and regulations.
<table>
<thead>
<tr>
<th>Course</th>
<th>Subject</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CIVIL AND ENVIRONMENTAL ENGINEERING</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>MECHANICAL ENGINEERING</td>
<td>29</td>
</tr>
<tr>
<td>3</td>
<td>MATERIALS SCIENCE AND ENGINEERING</td>
<td>51</td>
</tr>
<tr>
<td>4</td>
<td>ARCHITECTURE</td>
<td>64</td>
</tr>
<tr>
<td>5</td>
<td>CHEMISTRY</td>
<td>84</td>
</tr>
<tr>
<td>6</td>
<td>ELECTRICAL ENGINEERING AND COMPUTER SCIENCE</td>
<td>91</td>
</tr>
<tr>
<td>7</td>
<td>BIOLOGY</td>
<td>118</td>
</tr>
<tr>
<td>8</td>
<td>PHYSICS</td>
<td>128</td>
</tr>
<tr>
<td>9</td>
<td>BRAIN AND COGNITIVE SCIENCES</td>
<td>139</td>
</tr>
<tr>
<td>10</td>
<td>CHEMICAL ENGINEERING</td>
<td>149</td>
</tr>
<tr>
<td>11</td>
<td>URBAN STUDIES AND PLANNING</td>
<td>163</td>
</tr>
<tr>
<td>12</td>
<td>EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES</td>
<td>184</td>
</tr>
<tr>
<td>13</td>
<td>OCEAN ENGINEERING</td>
<td>204</td>
</tr>
<tr>
<td>14</td>
<td>ECONOMICS</td>
<td>205</td>
</tr>
<tr>
<td>15</td>
<td>MANAGEMENT</td>
<td>215</td>
</tr>
<tr>
<td>16</td>
<td>AERONAUTICS AND ASTRONAUTICS</td>
<td>241</td>
</tr>
<tr>
<td>17</td>
<td>POLITICAL SCIENCE</td>
<td>255</td>
</tr>
<tr>
<td>18</td>
<td>MATHEMATICS</td>
<td>269</td>
</tr>
<tr>
<td>Course 20</td>
<td>Biological Engineering</td>
<td>285</td>
</tr>
<tr>
<td>-----------</td>
<td>------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>Course 21</td>
<td>Humanities</td>
<td>292</td>
</tr>
<tr>
<td>Course 21A</td>
<td>Anthropology</td>
<td>295</td>
</tr>
<tr>
<td>Course 21F</td>
<td>Foreign Languages and Literatures</td>
<td>301</td>
</tr>
<tr>
<td>Course 21H</td>
<td>History</td>
<td>319</td>
</tr>
<tr>
<td>Course 21L</td>
<td>Literature</td>
<td>328</td>
</tr>
<tr>
<td>Course 21M</td>
<td>Music and Theater Arts</td>
<td>336</td>
</tr>
<tr>
<td>Course 21W</td>
<td>Writing and Humanistic Studies</td>
<td>349</td>
</tr>
<tr>
<td>Course 22</td>
<td>Nuclear Science and Engineering</td>
<td>356</td>
</tr>
<tr>
<td>Course 24</td>
<td>Linguistics and Philosophy</td>
<td>364</td>
</tr>
<tr>
<td>CMS</td>
<td>Comparative Media Studies</td>
<td>375</td>
</tr>
<tr>
<td>CSB</td>
<td>Computational and Systems Biology</td>
<td>382</td>
</tr>
<tr>
<td>ESD</td>
<td>Engineering Systems Division</td>
<td>383</td>
</tr>
<tr>
<td>HST</td>
<td>Health Sciences and Technology</td>
<td>395</td>
</tr>
<tr>
<td>MAS</td>
<td>Media Arts and Sciences</td>
<td>410</td>
</tr>
<tr>
<td>PBS</td>
<td>Project-based Subjects</td>
<td>416</td>
</tr>
<tr>
<td>ROTC</td>
<td>ROTC Programs</td>
<td>418</td>
</tr>
<tr>
<td>SP</td>
<td>Special Programs</td>
<td>422</td>
</tr>
<tr>
<td>STS</td>
<td>Science, Technology, and Society</td>
<td>431</td>
</tr>
<tr>
<td>SWE</td>
<td>Engineering School-wide Electives</td>
<td>440</td>
</tr>
<tr>
<td>School of Architecture and Planning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Art and Design/Course 4</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>Planning/Course 11</td>
<td>182</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School of Engineering</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace Engineering/Course 16-1</td>
<td>253</td>
</tr>
<tr>
<td>Aerospace Engineering with Information Technology/Course 16-2</td>
<td>253</td>
</tr>
<tr>
<td>Archaeology and Materials/Course 3-C</td>
<td>63</td>
</tr>
<tr>
<td>Biological Engineering/Course 20</td>
<td>291</td>
</tr>
<tr>
<td>Chemical-Biological Engineering/Course 10-B</td>
<td>162</td>
</tr>
<tr>
<td>Chemical Engineering/Course 10</td>
<td>160</td>
</tr>
<tr>
<td>Civil and Environmental Engineering/Course 1-A</td>
<td>28</td>
</tr>
<tr>
<td>Civil Engineering/Course 1-C</td>
<td>26</td>
</tr>
<tr>
<td>Computer Science and Engineering/Course 6-3</td>
<td>115</td>
</tr>
<tr>
<td>Electrical Engineering and Computer Science/Course 6-2</td>
<td>115</td>
</tr>
<tr>
<td>Electrical Engineering and Computer Science/Course 6-P</td>
<td>116</td>
</tr>
<tr>
<td>Electrical Science and Engineering/Course 6-1</td>
<td>115</td>
</tr>
<tr>
<td>Environmental Engineering Science/Course 1-E</td>
<td>27</td>
</tr>
<tr>
<td>Materials Science and Engineering/Course 3</td>
<td>62</td>
</tr>
<tr>
<td>Mechanical and Ocean Engineering/Course 2-OE</td>
<td>50</td>
</tr>
<tr>
<td>Mechanical Engineering/Course 2</td>
<td>48</td>
</tr>
<tr>
<td>Mechanical Engineering/Course 2-A</td>
<td>49</td>
</tr>
<tr>
<td>Nuclear Science and Engineering/Course 22</td>
<td>363</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School of Humanities, Arts, and Social Sciences</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthropology/Course 21A</td>
<td>300</td>
</tr>
<tr>
<td>Comparative Media Studies/Course CMS</td>
<td>381</td>
</tr>
<tr>
<td>Economics/Course 14</td>
<td>214</td>
</tr>
<tr>
<td>Foreign Languages and Literatures/Course 21F</td>
<td>318</td>
</tr>
<tr>
<td>History/Course 21H</td>
<td>327</td>
</tr>
<tr>
<td>Humanities/Course 21</td>
<td>292</td>
</tr>
<tr>
<td>Humanities and Engineering/Course 21E</td>
<td>293</td>
</tr>
<tr>
<td>Humanities and Science/Course 21S</td>
<td>293</td>
</tr>
<tr>
<td>Linguistics and Philosophy/Course 24-2</td>
<td>374</td>
</tr>
<tr>
<td>Literature/Course 21L</td>
<td>335</td>
</tr>
<tr>
<td>Music/Course 21M</td>
<td>348</td>
</tr>
<tr>
<td>Philosophy/Course 24-1</td>
<td>373</td>
</tr>
<tr>
<td>Political Science/Course 17</td>
<td>268</td>
</tr>
<tr>
<td>Science, Technology, and Society/Double Major/Course STS</td>
<td>439</td>
</tr>
<tr>
<td>Writing/Course 21W</td>
<td>355</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sloan School of Management</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Management Science/Course 15</td>
<td>240</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School of Science</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology/Course 7</td>
<td>127</td>
</tr>
<tr>
<td>Brain and Cognitive Sciences/Course 9</td>
<td>147</td>
</tr>
<tr>
<td>Chemistry/Course 5</td>
<td>90</td>
</tr>
<tr>
<td>Earth, Atmospheric, and Planetary Sciences/Course 12</td>
<td>202</td>
</tr>
<tr>
<td>Mathematics/Course 18</td>
<td>283</td>
</tr>
<tr>
<td>Mathematics with Computer Science/Course 18-C</td>
<td>284</td>
</tr>
<tr>
<td>Physics/Course 8</td>
<td>138</td>
</tr>
</tbody>
</table>
English Evaluation Test for international students, 9 am–12 noon.

Labor Day—Holiday

**Registration Day—Fall Term**

Number of class days (Wed, Sep 9, through Thu, Dec 10): 13 Mon, 12 Tue, 13 Wed, 13 Thu, 12 Fri = 63 days

**Deadline to change a Spring Term Exploratory subject to Listener status**

**First Day of Classes**

**Degree Application Deadline** for February SB and Advanced Degrees. $40 Late Fee ($75 after December 1).

**Registration Deadline.** Signed Registration forms for all students due in Student Services Center. $40 Late Fee.

**Deadline for Final-Term Seniors** to submit HASS Concentration Completion form. $40 Late Fee.

1 pm CAP September Degree Candidates Meeting

First-quarter Physical Education classes begin

Career Week

2 pm Graduate Academic Performance Meeting

Faculty Officers recommend degrees to Corporation

11 am–6 pm Fall Career Fair

**Minor Completion Date.** Deadline for submission of Minor Completion form for final-term seniors. $40 Late Fee.

Last day to sign up for family health insurance or waive individual coverage, E23-308

**Add Date.** Last day to add subjects to Registration

Last day for juniors/seniors to change an elective to or from P/D/F grading

Last day for graduate students to change a subject to or from P/D/F grading

Last day to change a subject from Listener to Credit

Last day for sophomores to change a subject to or from Exploratory

Late fee ($100) and petition required for students completing registration after this date

Last day to petition for second SB for June or next September degree candidates

Last day for June and September 2010 degree candidates to apply for double major

Deadline for completing cross-registration. $40 Late Fee for any petitions approved after this date.

Columbus Day—Holiday

**Monday Schedule of Classes To Be Held**

Family Weekend

Second-quarter Physical Education classes begin

Veterans Day—Holiday

**Drop Date.** Last day to cancel subjects from Registration.

Last day to change a subject from Credit to Listener

Last day to add a time-arranged subject that started after beginning of the term

Last day to petition for December Advanced Standing Exam (given during Final Exam Period)

Last day to add half-term subjects offered in second half of term

Thanksgiving Vacation
**ONLINE PREREGISTRATION** for Spring Term and IAP begins

**SUBJECTS WITH FINAL EXAM**—No test may be given and no assignment, term paper, or oral presentation shall fall due after this date.

**SUBJECTS WITH NO FINAL EXAM**—Undergraduate Subjects: No test may be given and at most one assignment may fall due between this date and the end of the last scheduled class period in the subject.

Graduate Subjects: Either one in-class test may be given or one assignment may fall due between this date and the end of the last regularly scheduled class in the subject.

**LAST DAY OF CLASSES**

Last day to drop half-term subjects offered in the second half of term

Last day to submit or change Advanced Degree Thesis Title. $75 Late Fee.

**FINAL EXAM PERIOD**

**GRADE DEADLINE.** Grades due in Registrar’s Office, 5-119, according to due date indicated on the Grade Sheet. Grade Sheets must be signed, enclosed in envelopes, sealed, and delivered to Registrar’s Office on or before due date.

**SPRING PREREGISTRATION DEADLINE.** Continuing students must initiate online preregistration by 5 pm on this date. $40 Late Fee ($75 after January 14).

First day of January Independent Activities Period

**DEADLINE FOR DOCTORAL STUDENTS** to submit application, signed by department, to Office of the Dean for Graduate Education, 3-138, for Spring Term Non-Resident status ($100 Late Fee). Not needed if Spring Term approved with Fall Term application.

Term Summaries of Fall Term grades delivered to departments

1 pm First-Year Grades Meeting

9 am Second-Year and Third-Year Grades Meeting

**THESIS DUE** for doctoral degrees

Last day to petition for January Advanced Standing Exam

9 am Fourth-Year Grades Meeting

2 pm Graduate Academic Performance Meeting

5 pm **FINAL DEADLINE FOR CONTINUING STUDENTS TO PREREGRISTER ONLINE.** $75 Late Fee.

**THESIS DUE** for degrees other than doctoral

**LAST DAY TO GO OFF THE FEBRUARY DEGREE LIST**

Martin Luther King, Jr. Day—Holiday

9 am CAP Deferred Action Meeting

9 am CAP Deferred Action Meeting

English Evaluation Test for international students, 9 am–12 noon

Last day of January Independent Activities Period

**REGISTRATION DAY—SPRING TERM**

Number of class days (Tue, Feb 2, through Thu, May 13): 12 Mon, 12 Tue, 14 Wed, 14 Thu, 13 Fri=65 days

**DEADLINE** to change a Fall Term Exploratory subject to Listener status

**FIRST DAY OF CLASSES**

**GRADES DUE** in Registrar’s Office, 5-119, for work completed in IAP
**REGISTRATION DEADLINE.** Signed Registration forms for all students due in Student Services Center. $40 Late Fee.

**DEGREE APPLICATION DEADLINE** for June SB and Advanced Degrees. $40 Late Fee ($75 Late Fee after April 3).

**DEADLINE FOR FINAL-TERM SENIORS** to submit HASS Concentration Completion form. $40 Late Fee.

Final deadline for all juniors to submit HASS Concentration Proposal form

**Term Summaries of grades for IAP delivered to departments**

Third-quarter Physical Education classes begin

2 pm Graduate Academic Performance Meeting

1 pm CAP February Degree Candidates Meeting

**MONDAY SCHEDULE OF CLASSES TO BE HELD**

Faculty Officers recommend degrees to Corporation

**MINOR COMPLETION DATE.** Deadline for submission of Minor Completion form for final-term seniors. $40 Late Fee.

**Last day to sign up for family health insurance or waive individual coverage, E23-308**

**MARCH**

<table>
<thead>
<tr>
<th>Mon</th>
<th>Tue</th>
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<th>Fri</th>
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<tbody>
<tr>
<td>22–26</td>
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<td>5 Fri</td>
<td>2 Fri</td>
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</tbody>
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**ADD DATE.** Last day to add subjects to Registration

Last day for juniors/seniors to change an elective to or from P/D/F grading

Last day for graduate students to change a subject to or from P/D/F grading

Last day to change a subject from Listener to Credit

Last day for sophomores to change a subject to or from Exploratory

Late fee ($100) and petition required for students completing registration after this date

Last day to petition for second SB for February 2011 degree candidates

Last day for February 2011 degree candidates to apply for a double major

Last day to drop half-term subjects offered in first half of term

Deadline for completing cross-registration. $40 Late Fee for petitions approved after this date.

Spring Vacation

**APRIL**

<table>
<thead>
<tr>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
</tr>
</thead>
<tbody>
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<td>9 Fri</td>
<td>12 Fri</td>
<td>22 Thu</td>
<td>30 Fri</td>
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</tr>
</tbody>
</table>

Last day to submit or change Advanced Degree Thesis Title. $75 Late Fee.

Campus Preview Weekend

Patriots Day—Vacation

**DROP DATE.** Last day to cancel subjects from Registration.

Last day to change a subject from Credit to Listener

Last day to add time-arranged subject that started after beginning of the term

Last day to petition for May Advanced Standing Exam (given during Final Exam Period)

Last day to add half-term subjects offered in second half of term

**THESIS DUE** for doctoral degrees
ONLINE PREREGISTRATION for Fall Term and Summer Session begins

SUBJECTS WITH FINAL EXAM—No test may be given and no assignment, term paper, or oral presentation shall fall due after this date.

SUBJECTS WITH NO FINAL EXAM—Undergraduate Subjects: No test may be given and at most one assignment may fall due between this date and the end of the last scheduled class period in the subject. Graduate Subjects: Either one in-class test may be given or one assignment may fall due between this date and the end of the last regularly scheduled class in the subject.

THESIS DUE for degrees other than doctoral

LAST DAY OF CLASSES
Last day to drop half-term subjects given in the second half of term

FINAL EXAM WEEK
GRADE DEADLINE. Grades due in Registrar’s Office, 5-119, according to due date indicated on the Grade Sheet. Grade Sheets must be signed, enclosed in envelopes, sealed, and delivered to Registrar’s Office on or before due date.

LAST DAY TO GO OFF THE JUNE DEGREE LIST
8 am Term Summaries of Spring Term grades delivered to departments

DEPARTMENT GRADUES MEETINGS
10 am Fourth-Year Grades Meeting
1 pm Graduate Academic Performance Meeting
Faculty Officers recommend degrees to Corporation

SUMMER SESSION PREREGISTRATION DEADLINE. Deadline for all students to preregister online for Summer Session. $40 Late Fee.

FALL PREREGISTRATION DEADLINE.Continuing students must initiate online preregistration by this date. $40 Late Fee ($75 after August 20).

MEMORIAL DAY—Holiday

2011

Jan 3 Mon Independent Activities Period begins
17 Mon Martin Luther King, Jr. Day—Holiday
28 Fri Independent Activities Period ends
31 Mon Registration Day—Spring Term; classes begin Tuesday

Feb 21 Mon Presidents Day—Holiday
22 Tue Monday schedule of classes

Mar 21–25 Mon–Fri Spring Vacation
Apr 18–19 Mon–Tue Patriots Day—Holiday
May 12 Thu Last day of classes (Final Exams, Mon–Fri, May 16–20)
Jun 3 Fri Commencement
SUBJECT KEY

This book lists MIT classes, or subjects, grouped by course number.

MIT course numbers (and abbreviations) refer to courses of study leading to specific academic degrees and, by extension, to the departments or programs offering those degrees.

These subject descriptions are accurate at the time of publication, but are subject to change. For current listings, consult the online Student Information System at http://student.mit.edu/catalog/index.cgi. The online information is updated as changes occur.

How to Read Subject Descriptions
A subject description consists of four parts: subject name, subject information, subject content, and instructor(s).

Subject Name
The subject name consists of its number and title.

J at the end of a subject number indicates that the subject is offered jointly by more than one department. Its subject numbers in the other departments are indicated in the subject information section.

(New) following the subject number and title indicates a subject that is new to the catalogue.

Subject Information
The subject information section may include the following:
If a subject has been renumbered, its former number appears in parentheses.
If a subject is jointly offered or is a school-wide elective (SWE), the phrase Same subject as followed by the subject’s other number(s) appears in parentheses.
Meets with appears if the subject is taught together with one or more subjects at a different level, or if part of the subject is taught in conjunction with another subject. Subjects that meet together generally have different coursework requirements.
Prerequisites are listed in this section or are indicated below in the subject content section. Students who have not completed the stated prerequisites must obtain the instructor’s permission to register. Numbers in italics indicate corequisites that must be taken simultaneously with the subject described. Prerequisites are listed before corequisites.
The use of “and” denotes that all of the subjects in a series are required, for example:
Prereq: 6.021J, 6.034, 6.046, and 18.417
The use of “or” denotes that just one of a series of prerequisites is required. When there are more than two options, commas are used, for example:
Prereq: 7.03, 7.05, 7.06, or 7.28
A semicolon is used to separate individual prerequisites from one of a series of prerequisites, or to separate several series of prerequisites, for example:
Prereq: 6.046J; 6.041 or 6.042J
Implicit prerequisites are not listed. For example, it is not necessary to list 6.02 as a prerequisite if 6.03 is already listed.
Because there are multiple versions of the subjects that satisfy General Institute Requirements (GIRs) in Science, those subjects are identified as GIRs when they appear as prerequisites and corequisites. Below are the current subjects that fulfill each requirement:

<table>
<thead>
<tr>
<th>Subject Name</th>
<th>Information</th>
<th>Content</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Calculus I (GIR): 18.01, 18.01A, 18.014</td>
<td>3-0-9 H-LEVEL Grad Credit</td>
<td>J. R. Williams</td>
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<td>Calculus II (GIR): 18.02, 18.02A, 18.022, 18.023, 18.024</td>
<td>Chemistry (GIR): 3.091, 5.111, 5.112</td>
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<td></td>
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<td>Physics I (GIR): 8.01, 8.01L, 8.011, 8.012</td>
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<td></td>
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<td>Acad Year may indicate “2009–2010: Not offered” or “2010–2011: Not offered.” There is no comment if the subject is offered in both academic years.</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Subject level and term follow. U is an undergraduate subject, and G is a subject offered primarily to graduate students. IAP is MIT’s Independent Activities Period.

Credit units, which indicate a subject’s time distribution, are represented by three numbers separated by dashes. First is the number of units assigned for recitation and lecture; second, the number of units for laboratory, design, or fieldwork; and third, the number of units for preparation. Add the units together to obtain the total credit for a subject.

One unit represents approximately 14 hours of work. Units arranged indicates that units are specially arranged with the instructor.

Subjects fulfilling the General Institute Requirements, such as BIOLOGY, PHYSICS I and II, CALCULUS I and II, CHEMISTRY, REST (Restricted Electives in Science and Technology), Institute LAB, or HASS-D (Humanities, Arts, and Social Sciences Distribution) are so designated to the right of the credit units.

Subjects fulfilling the Communication Requirement are designated CI-H or CI-HW. (See degree charts for CI-M designations.)

HASS indicates subjects that fulfill the Humanities, Arts, and Social Sciences Requirement (other than HASS-D subjects).

HASS-D Language Option indicates language subjects that may be substituted for one HASS-D subject.

[P/D/F] appears to the right of the credit units if the subject is graded on a P, D, or F basis (where P means C or better performance).

H-LEVEL Grad Credit indicates a subject approved for higher graduate-level credit. In some cases, a message follows to indicate that the subject is H-level in certain departments.

Can be repeated for credit appears under the credit units if the subject can be taken more than once for academic credit.

Subject Content
If a description of the subject content is not given, the associated subject number under which the description can be found appears instead. Any subject open only to special groups is so noted at the end of its content description.

Instructor(s)
The name of the instructor(s) as known at the time of publication, or the name of the department contact, appears in italics at the end of the subject description.
FUNDAMENTALS

1.00 Introduction to Computers and Engineering Problem Solving
(Subject meets with 1.001)
Prereq: Calculus I (GIR)
U (Fall, Spring)
5-1-6 REST

Fundamental software development and computational methods for engineering, scientific and managerial applications. Emphasis on object-oriented software design and development. Active learning using laptop computers (available on loan). Assignments cover programming concepts, graphical user interfaces, numerical methods, data structures, sorting and searching, computer graphics and selected advanced topics. The Java programming language is used.
Fall: V. J. Harward, G. Kocur
Spring: G. Kocur, C. Cassa

1.001 Introduction to Computers and Engineering Problem Solving
(Subject meets with 1.00)
Prereq: Calculus I (GIR)
G (Fall, Spring)
5-1-3

For graduate students who want to receive graduate credit for taking 1.00.
Fall: V. J. Harward, G. Kocur
Spring: G. Kocur, C. Cassa

1.010 Uncertainty in Engineering
Prereq: Calculus II (GIR)
U (Fall)
3-2-7

Introduction to probability and statistics with emphasis on engineering applications. Events and their probability, Total Probability and Bayes’ Theorems, discrete and continuous random variables and vectors, univariate and multivariate distributions, Bernoulli Trial Sequence and Poisson point process, uncertainty propagation and conditional analysis. Second-moment representation of uncertainty and second-moment uncertainty propagation and conditional analysis. Random sampling, estimation of distribution parameters (method of moments, maximum likelihood, Bayesian estimation), and simple and multiple linear regression. Concepts illustrated with examples from various areas of engineering and everyday life.
D. Veneziano

1.011 Project Evaluation
Prereq: None
U (Spring)
3-0-6

Methodologies for evaluating civil engineering projects, which typically are large-scale, long-lived projects involving many economic, financial, social, and environmental factors. Basic techniques of engineering economics, including net present value analysis, life-cycle costing, benefit-cost analysis, and other approaches to project evaluation. Resource and cost estimation procedures appropriate for large-scale infrastructure systems. Examples drawn from building design and construction, transportation systems, urban development, environmental projects, water resource management, and other elements of both the public and private infrastructure.
Staff

1.013 Senior Civil and Environmental Engineering Design
Prereq: Permission of instructor
U (Spring)
2-4-6

The project synthesizes prior design education. Students who have specialized in structural, geotechnical, engineering systems, and environmental areas form teams to design and plan a major project in a specific location. Students formulate the problem and demonstrate creativity in applying theories and methodologies from their design and analysis subjects to develop the project, with consideration of its technical, environmental, and social feasibility. Parallel to this major design project are smaller projects involving actual building. Lectures on a variety of civil and environmental engineering projects, as well as field trips, are also part of the subject. Instruction and practice in oral and written communication are an integral part, culminating in the completion of the design portfolio.
H. H. Einstein, P. Shahanah, L. O’Donnell

1.015) Design of Electromechanical Robotic Systems
(Same subject as 2.017J)
Prereq: 2.003; Coreq: 2.005 or 2.016; 2.671
U (Fall)
3-4-5 1/2 Institute LAB
See description under subject 2.017J.
F. S. Hover

1.016 Design for Complex Environmental Issues: Building Solutions and Communicating Ideas
Prereq: 12.000
U (Spring)
3-1-5

Provides an opportunity to pursue issues related to the Earth System problem studied during the Fall term Terrascope subject, 12.000. Student teams conceptualize, design and prototype devices intended to address the Earth System problem; they also create museum exhibits that communicate the context and proposed solutions to the problem. Teams develop a design concept with researchers at MIT and professionals from local museums, and display their exhibits to the MIT community. The Terrascope field trip provides first-hand experience and shapes the final designs. Limited to Terrascope students.
C. Harvey, A. Epstein

1.018) Ecology I: The Earth System
(Same subject as 7.30J)
Prereq: None
U (Fall)
3-1-8 REST

Fundamentals of ecology, considering Earth as an integrated dynamic system. Coevolution of the biosphere, geosphere, atmosphere and oceans. Introduction to thermodynamics. The Earth’s energy budget. Photosynthesis and respiration. The hydrologic, carbon and nitrogen cycles. Flow of energy and materials through ecosystems, regulation of the distribution and abundance of organisms, structure and function of ecosystems. Evolution and natural selection; metabolic diversity; productivity. Trophic dynamics; models of population growth, competition, mutualism and predation. Instruction
and practice in oral and written communication provided. 7.012–7.014 recommended.
S. W. Chisholm, E. Delong

1.020 Ecology II: Engineering for Sustainability
Prereq: Physics I (GIR); Coreq: 18.03 or permission of instructor
U (Spring)
3-2-7
Review of physical, chemical, ecological, and economic principles used to examine interactions between humans and the natural environment. Applications of mass balance concepts in ecology, chemical kinetics, hydrology, and transportation; energy balance concepts in building design, ecology, and climate change; economic and life cycle concepts in resource evaluation and engineering design. Numerical models used to integrate concepts and to assess environmental impacts of human activities. Problem sets involve development of MATLAB models for particular engineering applications. Some experience with computer programming is helpful but not essential.
D. McLaughlin

1.021 Introduction to Modeling and Simulation
Engineering School-Wide Elective Subject
(Offered under: 1.021, 3.021, 10.333, 22.00)
Prereq: 18.03, 3.016, or permission of instructor
U (Spring)
4-0-8 REST
See description under subject 3.021.
M. Buehler, N. Marzari, R. Radovitzky, T. Thonhauser

1.032 Geomaterials and Geomechanics
(Same subject as ESD.01J)
(Subject meets with 1.361, 1.366)
Prereq: 1.010, 1.011, 1.035, and 1.036
U (Fall)
3-0-9
Presentation and application of principles of soil mechanics. Considers topics: the origin and nature of soils; soil classification; the effective stress principle; hydraulic conductivity and seepage; stress-strain-strength behavior of cohesionless and cohesive soils and application to lateral earth stresses, bearing capacity and slope stability; consolidation theory and settlement analyses; laboratory and field methods for evaluation of soil properties in design practice. Same lectures as 1.361.
L. C. Jen

1.035 Mechanics of Structures and Soils
Prereq: 1.050, 18.03
U (Fall)
5-3-10
E. Kausel, R. Juanes, J. T. Germaine

1.036 Structural and Geotechnical Engineering Design
Prereq: 1.035
U (Spring)
3-1-8
Basic philosophy of planning and design of structures. Loading conditions, design criteria and factors of safety. Application of principles of structural mechanics and soil mechanics in design. Structural system design concepts. Design of reinforced concrete structural elements using the ultimate strength design method. Load factor design of structural steel members and connections. Selection of soil parameters from laboratory and in situ tests. Stability and ground deformations in geotechnical design. Design with soil-structure interaction. Emphasis on problem-based learning through team design projects.
O. Buyukozturk, L. C. Jen

1.040 Project Management
(Subject meets with 1.401J, ESD.018J)
Prereq: None
U (Spring)
3-0-9
Introduction to project management with emphasis on finance, evaluation, and organization. Topics include cost benefit analysis, resource and cost estimation, and project control and delivery. Case studies used to demonstrate relevant issues. Students taking graduate version complete additional assignments.
F. Moavenzadeh

1.041 Engineering System Design
(Same subject as ESD.01J)
Prereq: 1.011 or permission of instructor
U (Spring)
3-1-8
Deals with the design of complex, large, interconnected, open sociotechnical (CLIOS) systems, where “open” denotes systems that directly interact with the social/political/economic context. Emphasis on transportation-oriented examples. Introduces the CLIOS process, defining the concept and distinguishing between quantitative and qualitative analyses of such systems. Systems characterized, measures of system performance developed, and key CLIOS system concepts (including sustainability, equity, mobility, and accessibility) introduced. Class-wide project, with students working in teams on the design of a CLIOS system, taking a broad systems perspective in that design. Examples include the urban ring, a proposed new transit line for Boston; Tren Urbano in San Juan, Puerto Rico; the Central Artery/Ted Williams Tunnel project in Boston; and the transportation of spent nuclear fuel.
J. Sussman

1.044 J Fundamentals of Energy in Buildings
(Same subject as 2.66J, 4.42J)
Prereq: Physics I (GIR), Calculus II (GIR)
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-2-7 REST
See description under subject 4.42J.
L. R. Glicksman

1.050 Engineering Mechanics I
Prereq: Physics I (GIR); Coreq: Calculus II (GIR)
U (Fall)
3-2-7 REST
Basic principles of mechanics to describe the behavior of materials, structures and fluids. Dimensional analysis, conservation of momentum, static equilibrium, stress and stress states, hydrostatics, moments and forces. Material and structural strength criteria. Deformation and strain. Conservation of energy in solid mechanics, elasticity and elasticity bounds. Energy dissipation, plasticity and fracture. Open-ended geotechnical and structural engineering studio exercises and experiments with natural and man-made physical systems.
F. J. Ulm, M. J. Buehler
1.052) Mechanics of Structures
(Same subject as 2.012J)
Prereq: 2.001 or 1.050
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
4-1-7
See description under subject 2.012J.
T. Wierzbički, H. Schmidt

1.053) Dynamics and Control I
(Same subject as 2.003J)
Prereq: Physics I (GIR), 18.03
U (Fall, Spring)
4-1-7 REST
See description under subject 2.003J.
N. G. Hadjiconstantinou, J. K. Vanderwilt, N. C. Makris, N. M. Patrikalakis, T. Peacock

1.054 Mechanics and Design of Concrete Structures
(Subject meets with 1.541)
Prereq: 1.035
U (Fall)
3-0-9
Meets with graduate subject 1.541. Undergraduate level has the option of excluding special topics paper, but requires an assigned design project.
O. Buyukozturk

1.055 Steel Bridge Competition (New)
(Subject meets with 1.58)
Prereq: None
U (Fall, IAP, Spring)
0-4-0
Can be repeated for credit
Students participate in the ASCE/AISC Student Bridge Competition, gaining practical experience in structural design, steel fabrication processes, construction planning, organization, and teamwork. Provides an opportunity to compete against, and network with, students from other colleges and universities from around the country.
J. J. Connor

1.058 Structural Dynamics & Vibrations
(Subject meets with 1.581J, 2.060J, 16.221J)
Prereq: Permission of instructor
U (Fall)
3-1-8
Single- and multiple-degree-of-freedom vibration problems, using matrix formulation and normal mode superposition methods. Time and frequency domain solution techniques including convolution and Fourier transforms. Applications to vibration isolation, damping treatment, and dynamic absorbers. Analysis of continuous systems by exact and approximate methods. Applications to buildings, ships, aircraft, and offshore structures. Vibration measurement and analysis techniques. Students should possess basic knowledge in structural mechanics and in linear algebra. Students taking graduate version complete additional assignments.
E. Kausel

1.060 Engineering Mechanics II
Prereq: Permission of instructor or Coreq: 18.03
U (Spring)
3-2-7
Mechanics principles for incompressible fluids and their interactions with solid materials.
Review of hydrostatics. Conservation of mass, momentum and energy in fluid mechanics. Flow nets, velocity distributions in laminar and turbulent flows, groundwater flows. Momentum and energy principles in hydraulics, with emphasis on open channel flow and hydraulic structures.
O. S. Madsen, R. Stocker

1.061 Transport Processes in the Environment
(Subject meets with 1.61)
Prereq: 1.060
U (Fall)
3-1-8
Introduction to mass transport in environmental flows, with emphasis given to river and lake systems. Derivation and solutions to the differential form of mass conservation equations. Topics include: molecular and turbulent diffusion, boundary layers, dissolution, bed-water exchange, air-water exchange and particle transport.
H. M. Nepp

1.070 Introduction to Hydrology
(Same subject as 12.320J)
Prereq: 1.060; Coreq: 1.062, 1.106
U (Fall)
3-0-9
Introduction to the global water and energy cycles and the earth system including the atmosphere, oceans, land, and biosphere. Fundamentals of hydrologic science and its applications. Covers bases for the characterization of hydrologic processes such as precipitation, evaporation, transpiration by vegetation, infiltration, and storm runoff. Understanding and modeling of groundwater flow, hydraulic hills of wells, and subsurface transport of pollutants. Probabilistic analysis and risk estimation for hydrologic variables.
D. Entekhabi

1.071) Global Change Science
(Same subject as 12.300J)
Prereq: 18.03; 5.60
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9
Introduces the basic relevant principles and concepts in atmospheric physics, climate dynamics, biogeochemistry, and water and energy balance at the land-atmosphere boundary, through an examination of two current problems in the global environment: carbon dioxide and global warming; and tropical deforestation and regional climate. An introduction to global environmental problems for students in basic sciences and engineering.
E. A. B. Eltahir

1.080 Environmental Chemistry and Biology
Prereq: Chemistry (GIR); Biology (GIR)
U (Spring)
4-0-8
Covers basic environmental chemistry and biology with a focus on understanding the principles governing the function of both natural systems and systems perturbed or engineered by humans. Topics include acid-base, complexation, reduction/oxidation, precipitation, hydrolysis and sorption reactions, population growth and limiting factors, microbial community structure, and the interactions between microbes and their chemical environment. 1.018 and concurrent enrollment in 1.107 recommended.
P. M. Gschwend, E. J. Alm, M. F. Polz

1.081J) Environmental Risks for Common Disease
(Same subject as 20.104J, ESD.053J)
Prereq: Biology (GIR), Chemistry (GIR)
U (Spring)
3-0-9
See description under subject 20.104J.
W. Thilly, R. McCunney

1.083 Environmental Health Engineering
Prereq: 1.061 or permission of instructor
U (Spring)
3-0-9
Consideration of human health issues associated with environmental engineering for air, land, and water systems. Fate and transport of environmental contaminants; toxicology, exposure pathways, and risk assessment; treatment technology, and basis for environmental
regulation of chemical exposure. Case studies illustrate concepts and issues.

*J. Thompson*

**1.084j** Systems Microbiology  
(Same subject as 20.106j)  
Prereq: Chemistry (GIR), Biology (GIR)  
U (Fall)  
3-0-9  
See description under subject 20.106j.  
*E. DeLong*

**UNDERGRADUATE LABORATORY SUBJECTS**

**1.101 Introduction to Civil and Environmental Engineering Design I**  
Prereq: 1.018, 1.050  
U (Fall)  
0-3-3 1/2 Institute LAB  
Project-oriented introduction to the principles and practice of civil and environmental engineering design. First half of the term, students work in teams to apply the design process to an open-ended design/planning problem involving civil and environmental engineering aspects. In the second half, teams design and build a working model demonstrating, in detail, an aspect of the planning/design project. Each team then uses the model to teach the rest of the class the concepts they have chosen to study in depth. Regular written and oral presentations. Students also start on their design portfolio.  
*H. Einstein, A. Epstein, S. Rudolph*

**1.102 Introduction to Civil and Environmental Engineering Design II**  
Prereq: Permission of instructor and Coreq: 1.060  
U (Spring)  
1-3-2 1/2 Institute LAB  
Project-oriented subject focused on the principles and practice of engineering design. Emphasis on construction and deployment of designs, plus performance testing used to determine if designs behave as expected. Subject includes a major team project involving use and application of sensors, as well as environmentally-friendly, and energy-effective or energy-producing designs. Further development of hands-on, teamwork and communication skills. Enrollment limited; preference given to Course 1 students.  
*H. F. Hemond, J. T. Germaine*

**1.106 Environmental Fluid Transport Processes and Hydrology Laboratory**  
Prereq: None. Coreq: 1.061, 1.070  
U (Fall)  
0-4-2 1/2 Institute LAB  
Builds on the lecture subjects 1.061 and 1.070. Fundamentals of mass and flow measurements in field and laboratory settings, and application of these measurement techniques to analyze real and model environmental systems. Enrollment limited; preference given to 1E and 1A students.  
*H. M. Nepf, D. Entekhabi*

**1.107 Environmental Chemistry and Biology Laboratory**  
Prereq: None. Coreq: 1.080  
U (Spring)  
0-4-2 1/2 Institute LAB  
Laboratory and field techniques in biogeochemistry and environmental engineering and their application to the understanding of natural and engineered ecosystems. Exercises demonstrate data acquisition and modeling suited to identifying and quantifying physical, chemical, and biological processes that govern the effects of human activity on the functioning of natural systems and/or the efficacy of engineered approaches to environmental problems. Applications include chemical and biological remediation, measurement of contaminants, and detection of biogeochemical activity in natural environments. An independently designed final project is required. 1.018 and 1.061 strongly recommended. Enrollment limited; preference to Course 1-E majors.  
*M. Polz, S. Frankel, P. Gschwend*

**ENGINEERING INFORMATION SYSTEMS AND COMPUTATION**

**1.126j** Pattern Recognition and Analysis  
(Same subject as MAS.622J)  
Prereq: A working knowledge of probability theory and linear algebra  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
See description under subject MAS.622J.  
*J. Williams, D. Hartzband, A. Sanchez*

**1.125j** Architecting Software Systems  
(Same subject as ESD.341J)  
Prereq: 1.00, 1.124j, or permission of instructor  
G (Fall)  
2-0-4 H-LEVEL Grad Credit  
See description under subject ESD.341J.  
*J. Williams, D. Hartzband, A. Sanchez*

**1.128j** Computational Geometry  
(Same subject as 2.089J)  
Prereq: Permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 2.089J.  
*N. M. Patrikalakis, D. C. Gossard*

**ENGINEERING ANALYSIS METHODS**

**1.133 MEng Concepts of Engineering Practice**  
Prereq: None  
G (Fall)  
3-0-6 H-LEVEL Grad Credit  
Core requirement for the MEng program designed to teach students about the roles of today's professional engineer and expose them to team-building skills through lectures, team workshops, and seminars. Topics include: written and oral communication, job placement skills, trends in the engineering and construction industry, risk analysis and risk management, managing public information, proposal preparation, project evaluation, project management, liability, professional ethics, and negotiation. Draws on relevant large-scale projects to illustrate each component of the subject. Grading
is based on both individual and team exercises involving written and oral presentations. Limited to Course 1 MEng students.

E. E. Adams

1.138| Wave Propagation
(Same subject as 2.062J, 18.376J)
Prereq: 2.003J, 18.075
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.062J.

T. R. Akylas, R. R. Rosales

See also 1.351, 1.541, 1.56J, 1.63, 1.691.

ENGINEERING SYSTEMS, ECONOMICS, AND OPTIMIZATION

1.142| Systems Optimization: Models and Computation
(Same subject as 15.094J)
Prereq: 18.06 or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.094J.

R. M. Freund

1.145| Engineering Economy Module
(Same subject as ESD.70J)
Prereq: None
G (Fall)
1-0-2 [P/D/F]
See description under subject ESD.70J.

R. de Neufville

1.146| Engineering Systems Analysis for Design
Engineering School-Wide Elective Subject
(Offered under: 1.146, 3.56, 16.861, ESD.71)
Prereq: 1.145J or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject ESD.71.

R. de Neufville

1.149| Applications of Technology in Energy and the Environment
Engineering School-Wide Elective Subject
(Offered under: 1.149, 2.63, 5.00, 10.579, 22.813, ESD.17A)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.813.

J. Deutch, R. Lester

See also 1.096J, 1.202, 1.203J, 1.207, 1.283J, 1.731. For management of engineering systems, see also 1.040, 1.401–1.482.

ENGINEERING RISK ASSESSMENT AND PROBABILISTIC ANALYSIS

1.151| Probability and Statistics in Engineering
Prereq: None
G (Spring)
3-0-9 H-LEVEL Grad Credit

D. Veneziano

1.155| Engineering Risk-Benefit Analysis
Engineering School-Wide Elective Subject
(Offered under: 1.155, 2.963, 3.577, 6.938, 10.816, 16.862, 22.82, ESD.72)
Prereq: Calculus II (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.72.

G. E. Apostolakis

See also 1.203J.

TRANSPORTATION

1.200| Transportation Systems Analysis: Performance and Optimization
(Same subject as 11.544J, ESD.210J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
Introduces transportation systems analysis, stressing demand and economic aspects. Covers the key principles governing transportation planning, investment, operations, and maintenance. Introduces the microeconomic concepts central to transportation systems. Topics include economic theories of the firm, consumer, and market, demand models, discrete choice analysis, cost models and production functions, and pricing theory. Applications to transportation systems include congestion pricing, technological change, resource allocation, market structure and regulation, revenue forecasting, public and private transportation finance, and project evaluation; covering urban passenger transportation, freight, aviation and intelligent transportation systems.

N. H. M. Wilson, M. Ben-Akiva

1.201| Transportation Systems Analysis: Demand and Economics
(Same subject as 11.545J, ESD.212J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
Introduces transportation systems analysis, stressing demand and economic aspects. Covers the key principles governing transportation planning, investment, operations, and maintenance. Introduces the microeconomic concepts central to transportation systems. Topics include economic theories of the firm, consumer, and market, demand models, discrete choice analysis, cost models and production functions, and pricing theory. Applications to transportation systems include congestion pricing, technological change, resource allocation, market structure and regulation, revenue forecasting, public and private transportation finance, and project evaluation; covering urban passenger transportation, freight, aviation and intelligent transportation systems.

N. H. M. Wilson, M. Ben-Akiva

1.202| Demand Modeling
(Same subject as ESD.212J)
Prereq: Permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit
Theory and application of modeling and statistical methods for analysis and forecasting of demand for facilities, services, and products. Topics include review of probability and statistics, estimation and testing of linear regression models, theory of individual choice behavior, derivation, estimation, and testing of discrete choice models (including logit, nested logit, GEV, probit, and mixture models), estimation under various sample designs and data collection methods (including revealed and stated preferences), sampling, aggregate forecasting methods, and iterative proportional fitting and related methods. Lectures reinforced with case studies, which require specification, estimation, testing, and analysis of models using data sets from actual applications.

Staff
1.203 J Logistical and Transportation Planning Methods
(Same subject as 6.281J, 15.073J, 16.76J, ESD.216J)
Prereq: 6.041
G (Fall)
3-0-9 H-LEVEL Grad Credit
Quantitative techniques of operations research with emphasis on applications in transportation systems analysis (urban, air, ocean, highway, and pickup and delivery systems) and in the planning and design of logistically oriented urban service systems (e.g., fire and police departments, emergency medical services, and emergency repair services). Unified study of functions of random variables, geometrical probability, multi-server queuing theory, spatial location theory, network analysis and graph theory, and relevant methods of simulation. Computer exercises and discussions of implementation difficulties.

1.204 J Computer Algorithms in Systems Engineering
Prereq: 1.001 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
G. Kocur

1.205 J Advanced Demand Modeling
(Same subject as ESD.213J)
Prereq: 1.202 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Advanced theories and applications of models for analysis and forecasting of users' behavior and demand for facilities, services, and products. Topics vary each year and typically include linear and nonlinear latent variable models, including structural equations and latent class models; estimation techniques with multiple data sources; joint discrete and continuous choice models; dynamic models; analysis of panel data; analysis of complex choices; estimation and forecasting with large choice sets; multidimensional probabilistic choice models; advanced choice models, including probit, logit mixtures, treatment of endogeneity, hybrid choice models, hidden Markov models, Monte Carlo simulation, Bayesian methods, survey design, sampling, model transferability, and use of stated preferences data. Term paper required
M. E. Ben-Akiva

1.206 J Airline Schedule Planning
(Same subject as 16.77J, ESD.215J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Explores a variety of models and optimization techniques for the solution of airline schedule planning problems. Schedule design, fleet assignment, aircraft maintenance routing, crew scheduling, robust planning, integrated scheduling, and other topics are addressed. Models and solution techniques are surveyed and state-of-the-art applications of these techniques to airline problems are presented.
C. Barnhart

1.212 J An Introduction to Intelligent Transportation Systems
(Same subject as ESD.221J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-6 H-LEVEL Grad Credit
Basic elements of intelligent transportation systems. Technological, systems, and institutional aspects of ITS considered, including dynamic traffic management, traffic modeling, data communications, communication infrastructure, traffic signals and control, traffic data and information, traffic signal systems, and software for ITS. An introduction to optimization techniques to airline problems are presented.
J. Sussman

1.231 J Planning and Design of Airport Systems
(Same subject as 16.781J, ESD.224J)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Equal emphasis on current practice and advanced concepts. Airport location and planning with full consideration of economic, environmental, and other impacts. Demand prediction, determination of the capacity of the airfield, and estimation of levels of congestion. Design of terminals. Role of airports in the aviation and transportation system. Airport access problems. Optimal configuration of air transport networks and implications for airport development. Economics of the airport. Financing and institutional aspects. Special attention to international practice and developments.
R. de Neufville, A. R. Odoni

1.232 J The Airline Industry
(Same subject as 15.054J, 16.71J, ESD.217J)
Prereq: None
G (Fall)
3-0-9
See description under subject 16.71J.

1.234 J Airline Management
(Same subject as 16.75J)
Prereq: 16.71J
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.75J.
P. P. Belobaba

1.251 J Comparative Land Use and Transportation Planning
(Same subject as 11.526J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.526J.
C. Zegras

1.252 J Urban Transportation Planning (11.540)
(Same subject as 11.540J, ESD.225J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
History, policy, and politics of urban transporta- tion. The role of the federal government and the “highway revolt.” Public transit in the auto era. Analytic tools for transportation planning and policy analysis. The contribution of transportation to air pollution and climate change. Land use and transportation interactions. Bicycles, pedestrians, and traffic calming. Examples from the Boston area.
F. Salvucci, M. Murga

1.253 J Transportation Policy and Environmental Limits
(Same subject as 11.543J, ESD.222J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Through a combination of lectures, cases, and class discussions the subject examines the economic and political conflict between transportation and the environment. Investigates the role of government regulation, green business and
transportation policy as a facilitator of economic development and environmental sustainability. Analyzes a variety of international policy problems including government-business relations, the role of interest groups, non-governmental organizations, and the public and media in the regulation of the automobile; sustainable development; global warming; politics of risk and siting of transport facilities; environmental justice; equity; as well as transportation and public health in the urban metropolis. Provides students with an opportunity to apply transportation and planning methods to develop policy alternatives in the context of environmental politics.

J. Coughlin, F. Salvucci

1.254 Transport Modeling Course
Prereq: Permission of instructor
G (Spring)
3-0-9

Fosters practical experience with the concepts and approaches behind the analytical chain composed by GIS, 4-step planning and traffic models. Study conducted in Greater Boston. Students develop road and street, pedestrian and public transportation networks. The latest CTPP data, and Boston home travel survey used to understand travel behavior and calibrate model. Final project involves the design of alternative futures for the metropolitan area with different transportation and land use policies. Basic programming experience required.

M. Murga

1.255 Transportation MEng Project
Prereq: Permission of instructor
G (Fall, IAP, Spring)
5-0-10

Core requirement for the Transportation MEng program. Students work on projects related to ongoing MIT research programs with agencies, industries and government, such as the Chicago Transit Authority, Transport for London, or related transportation projects in the Boston area. An in-depth design study is carried out as a group effort and provides the background for individual student theses. Students must register for 1.255 for the Fall term, IAP, and the Spring term. Limited to Course 1 MEng students.

N. Wilson, J. Attanucci, M. Murga

1.258 Public Transportation Systems
(Same subject as 11.541J, ESD.226J)
Prereq: 1.201J or permission of instructor
G (Spring)
3-0-9

Evolution and role of urban public transportation modes, systems, and services, focussing on bus and rail. Description of technological characteristics and their impacts on capacity, service quality, and cost. Current practice and new methods for data collection and analysis, performance monitoring, route design, frequency determination, and vehicle and crew scheduling. Effect of pricing policy and service quality on ridership. Methods for estimating costs associated with proposed service changes. Organizational models for delivering public transportation service including finance and operations.

N. H. M. Wilson

1.260J Logistics Systems
(Same subject as 15.770J, ESD.260J)
Prereq: Permission of instructor
G (Fall)
3-0-9

See description under subject ESD.260J.

Y. Sheffi, C. Caplice

1.261J Case Studies in Logistics and Supply Chain Management
(Same subject as 15.771J, ESD.261J)
Prereq: Permission of instructor
G (Spring)
3-0-6

See description under subject ESD.261J.

J. Byrnes

1.262J Supply Chain Context
(Same subject as ESD.262J)
Prereq: ESD.260 or permission of instructor
G (IAP)
2-0-4 [P/D/F]

See description under subject ESD.262J.

J. Goentzel, C. Caplice

1.264J Database, Internet, and Systems Integration Technologies
(Same subject as ESD.264J)
Prereq: Permission of instructor
G (Fall)
5-0-7

Information technology fundamentals: software process, data modeling, UML, relational databases and SQL. Internet technologies: http, xhtml, XML, Web services. Introduction to security. Fundamentals of telecommunications. Students complete project that covers requirements/design, data model, database implementation, website, and system architecture. No prior programming experience required.

G. Kocur

1.265J International Supply Chain Management
(Same subject as 2.965J, 15.765J, ESD.265J)
Prereq: 1.260J, 1.261J, 1.262J, 15.760, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring; first half of term)
2-0-4

An overview of globalization and the international environment: the international marketing, international finance and supply chain interface; global strategy for logistics and supply chain management; global supply chain models; role of government intervention and regulations; the role of international air and ocean carriers. Emphasis on both strategy formulation and implementation.

Staff

1.270J Logistics and Supply Chain Management
(Same subject as ESD.273J)
Prereq: Probability and Linear Programming
G (Fall)
3-0-9

See description under subject ESD.273J.

D. Simchi-Levi

1.272J Design and Operation of Logistics Facilities and Networks
(Same subject as ESD.272J)
Prereq: 1.260J or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (IAP)
2-0-1

See description under subject ESD.272J.

C. Caplice

1.273J Supply Chain Planning
(Same subject as 15.762J, ESD.267J)
Prereq: 1.260J, 15.760, or 15.761
G (Spring)
2-0-4

See description under subject 15.762J.

S. C. Graves, D. Simchi-Levi
1.274 Manufacturing System and Supply Chain Design
(Same subject as 15.763J, ESD.268J)
Prereq: 1.260, 15.760, or 15.761
G (Spring)
2-0-4 H-LEVEL Grad Credit
See description under subject 15.763J.
S. C. Graves, D. Simchi-Levi

1.283 Cities and Regions: Urban Economics and Public Policy
(Same subject as 11.410J, 14.573J, ESD.191J)
Prereq: 14.03 or 14.04
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 14.573J.
W. Wheaton

1.284 Analyzing and Accounting for Regional Economic Change
(Same subject as 11.481J, ESD.192J)
Prereq: 14.03, 14.04
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.481J.
K. R. Polenske

1.285 Regional Socioeconomic Impact Analyses and Modeling
(Same subject as 11.482J, ESD.193J)
Prereq: 11.481J or permission of instructor
G (Fall)
2-1-9 H-LEVEL Grad Credit
See description under subject 11.482J.
K. R. Polenske

GEOENVIRONMENTAL AND GEOTECHNICAL ENGINEERING

1.322 Soil Behavior
Prereq: 1.361
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
4-0-8 H-LEVEL Grad Credit
Detailed study of soil properties with emphasis on interpretation of field and laboratory test data and their use in soft-ground construction engineering. Includes: consolidation and secondary compression; basic strength principles; stress-strain strength behavior of clays, emphasizing effects of sample disturbance, anisotropy, and strain rate; strength and compression of granular soils; and engineering properties of compacted soils. Some knowledge of field and laboratory testing assumed; 1.37 desirable.
A. J. Whittle

1.331 Advanced Soil Dynamics
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
E. Kausel

1.34 Waste Containment and Remediation Technology
Prereq: 1.72 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Hazardous waste site remediation and waste disposal facility design. Introduction to hazardous waste including the definition of hazardous waste, regulatory requirements under RCRA and CERCLA, waste characteristics, environmental chemistry, hydrology, and contaminant transport. Characterization of contaminated sites, preliminary site assessment, site investigation techniques, remediation technologies for soil and groundwater, risk assessment, and monitoring. The design, construction, operation, and hydrology of landfills and waste disposal facilities.
P. Shanahan

1.351 Theoretical Soil Mechanics
Prereq: 1.361
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
A. J. Whittle

1.361 Advanced Soil Mechanics
(Subject meets with 1.032, 1.366)
Prereq: 1.035, 1.036
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.032.
L. C. Jen

1.364 Advanced Geotechnical Engineering
Prereq: None. Coreq: 1.361
G (Fall)
4-0-8 H-LEVEL Grad Credit
Site characterization and geotechnical aspects of the design and construction of foundation systems. Topics include site investigation (with emphasis on in situ testing), shallow (footings and raftings) and deep (piles and caissons) foundations, excavation support systems, groundwater control, slope stability, soil improvement (compaction, soil reinforcement, etc.), and construction monitoring. Core requirement for Geotechnical MEng program.
A. J. Whittle

1.366 Geotechnical Engineering
(Subject meets with 1.032, 1.361)
Prereq: 1.035, 1.036
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject 1.032.
L. C. Jen

1.37 Geotechnical Measurements and Exploration
Prereq: 1.035
G (Fall)
3-4-2 H-LEVEL Grad Credit
Application of testing principles to the measurement of fundamental aspects of soil behavior from classification to engineering properties. Emphasis on rigorous techniques to measure mechanical behavior under various boundary conditions. Exposure to error estimation, research devices, geotechnical field exploration, and in situ testing. Extensive laboratory experiments to explore geotechnical test equipment and techniques. Laboratory use of testing automation and electronic instrumentation. Experiments include data analysis, evaluation, and presentation.
J. T. Germaine
1.38 Engineering Geology
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
Effect of geologic features and processes on constructed facilities; interaction between man-made structures and human activities in general, and the geologic environment. Planning of subsurface exploration. Engineering geologic characterization of soil and rock, including joint surveys and aspects of sedimented and residual soils. Laboratory on basic geologic identification and mapping techniques. Extensive reading of case histories. Field trip.
H. H. Einstein

1.381 Rock Mechanics
Prereq: 1.38, 1.361
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-6 H-LEVEL Grad Credit
Introduces theoretical and experimental aspects of rock mechanics and on this basis prepares the student for rock engineering. Includes review of laboratory and field testing; empirical and analytical methods for describing strength, deformability, and permeability of intact rock and rock masses; fracture mechanics and mechanics of discontinua including flow through discontinua; design and analysis of rock slopes and foundations on rock; and discussion of blasting design.
H. H. Einstein

1.383 Underground Construction
Prereq: 1.361, 1.38, or permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit
Familiarization with the most important aspects of planning, design, and construction of underground openings in soft ground and rock. Detailed engineering analysis and design. Major aspects of construction techniques and construction planning. Discussion of general planning and economic problems. Major design project.
H. H. Einstein

1.39 Studies in Geotechnical Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
For graduate students desiring further individual study of special topics.
Information: A. J. Whittle

CONSTRUCTION ENGINEERING AND MANAGEMENT

1.401J Project Management
(Same subject as ESD.018J)
(Subject meets with 1.040)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Introduction to project management with emphasis on finance, evaluation, and organization. Topics include cost benefit analysis, resource and cost estimation, and project control and delivery. Case studies used to demonstrate relevant issues. Students taking graduate version complete additional assignments.
F. Moavenzadeh

1.462J Entrepreneurship in Construction and Real Estate Development
(Same subject as 11.345J)
Prereq: Permission of instructor
G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
See description under subject 11.345J.
J. F. Kennedy

1.463J The Impact of Globalization on the Built Environment
(Same subject as 11.342J, ESD.53J)
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit
Addresses the importance and pervasiveness of Globalization in Architecture, Engineering and Construction Companies (AEC Firms). Covers strategies for a presence in the global market and the importance of the global financial market in project financing, with a primary focus on infrastructure. Includes discussion of innovative approaches to marketing, partnering, risk management, finance, specialized delivery systems, and privatization.
F. Moavenzadeh, D. Wolff

1.472J Innovative Project Delivery in the Public and Private Sectors
(Same subject as 11.344J)
Prereq: Permission of instructor
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
See description under subject 11.344J.
C. M. Gordon

1.482 Studies in Construction Engineering and Management
Prereq: None
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Individual study of an advanced topic in construction engineering and management, selected with approval of faculty supervisor.
F. Moavenzadeh

MATERIALS AND STRUCTURES

1.541 Mechanics and Design of Concrete Structures
(Subject meets with 1.054)
Prereq: 1.051
G (Fall)
3-0-9 H-LEVEL Grad Credit
O. Buyukozturk

1.545 Atomistic Modeling and Simulation of Materials and Structures
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Covers multi-scale atomistic modeling and simulation methods, with focus on mechanical properties (elasticity, plasticity, creep, fracture, fatigue) of a range of materials (metals, ceramics, proteins, biological materials, biomaterials). Topics include mechanics of materials (energy principles, nano-/micromechanics, deformation mechanisms, size effects, hierarchical biological structures) and atomistic modeling (chemistry, interatomic potentials, visualization, data analysis, numerical methods, supercomputing, algorithms). Subject involves hands-on computational project.
M. J. Buehler
1.561 Structural Mechanics in Nuclear Power Technology
(Same subject as 2.086J, 22.314J)
Prereq: 2.001 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.314J.
M. S. Kazimi, O. Buyukozturk

1.562 High-Performance Structures MEng Project
Prereq: None. Coreq: 1.561 and 1.583J
G (Fall, IAP, Spring)
5-0-10 H-LEVEL Grad Credit
Core requirement for the High Performance Structures MEng program. Focus on the conceptual design of complex structures and the use of advanced technologies to improve the performance of structural systems with respect to their durability, constructability, efficiency and sustainability. An in-depth design study is carried out as a group effort and provides the background for individual student theses. Students must register for 1.562 for the Fall term, IAP, and the Spring term. Limited to Course 1 MEng students. J. J. Connor, Jr.

Prereq: 1.050, 1.57; or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduction to fracture mechanics, poromechanics and micromechanics using a unified mechanistic approach based on energy principles for modeling a large range of man-made and natural engineering material behavior. Energy release and fracture energy, stress intensity factors and toughness, saturated and partially saturated poromechanics of deformable porous materials, Darcy’s law, linear micromechanics and application to porous materials, homogenization methods, chemomechanics of dissolution processes. In addition to assignments, emphasizes development of a consistent engineering science approach, culminating in a term paper. F. I. Ulm

1.564J Structural Mechanics and Micromechanics
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
An introduction to micromechanics and modeling of engineering materials based on thermodynamics of irreversible processes. Introduction to continuum mechanics and material modeling of engineering materials based on first energy principles: deformation and strain; momentum balance, stress, and stress states; elasticity and plasticity bounds; plasticity and yield design. Overarching theme is a unified mechanistic language using thermodynamics, which allows for understanding, modeling, and design of a broad range of engineering materials. F. I. Ulm

1.565J Micromechanics and Durability of Solids
Prereq: 1.050, 1.57; or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduction to fracture mechanics, poromechanics and micromechanics using a unified mechanistic approach based on energy principles for modeling a large range of man-made and natural engineering material behavior. Energy release and fracture energy, stress intensity factors and toughness, saturated and partially saturated poromechanics of deformable porous materials, Darcy’s law, linear micromechanics and application to porous materials, homogenization methods, chemomechanics of dissolution processes. In addition to assignments, emphasizes development of a consistent engineering science approach, culminating in a term paper. F. I. Ulm

1.566J Structural Analysis and Control
Prereq: 1.052
G (Fall)
3-0-9 H-LEVEL Grad Credit

1.567J Structural Systems
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit
Designed to complement general structural analysis classes. Provides an understanding of the full range of structures and structural forms, including how they are designed and built. Develops skills necessary for conceptual design work, such as how to visualize options and judge their relative advantages in a qualitative manner. Case studies demonstrate how to conceive a structural form and consider its various options, and to understand assembly and construction methods intrinsic to the real behavior of the final structure. P. Kassabian

1.568J Structural Dynamics and Vibrations
(Same subject as 2.060J, 16.221J)
(Subject meets with 1.058)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
Single- and multiple-degree-of-freedom vibration problems, using matrix formulation and normal mode superposition methods. Time and frequency domain solution techniques including convolution and Fourier transforms. Applications to vibration isolation, damping treatment, and dynamic absorbers. Analysis of continuous systems by exact and approximate methods. Applications to buildings, ships, aircraft and offshore structures. Vibration measurement and analysis techniques. Students should possess basic knowledge in structural mechanics and in linear algebra. Students taking graduate version complete additional assignments. E. Kausel, J. K. Vandiver

1.569J Design of Steel Structures
Prereq: Permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit
Provides ability to design and assess steel structures. Steel structures are taught at three levels: the overall structural system (multi-story buildings, wide-span buildings, bridges, masts, and towers); the components of a structural system (floor systems, plate girders, frames, and beams); and the details of structural components (connection types, welding, and bolting). Each level includes a balance among theoretical analysis, design requirements, and construc-
tion/cost considerations. Existing structures are used as worked examples.

P. Kassabian

1.588J Communicating About Technology: Colossal Failures in Engineering
(Same subject as 3.070J, 22.002J, 21W.781J, ESD.032J)
Prereq: None
U (Spring)
3-0-9 HASS, CI-H
See description under subject 21W.781J.
T. Eagar, W. Haas, A. Kadak, P. Lagacé, O. Buyukozturk

1.589 Studies in Structural Design and Analysis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Individual study of advanced subjects under staff supervision. Content arranged to suit the particular requirements of the student and interested members of the staff.
Information: O. Buyukozturk

1.597 Studies in Construction Materials
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Advanced topics in construction materials selected by students for individual study with staff approval.
Information: O. Buyukozturk

HYDRODYNAMICS AND COASTAL ENGINEERING

1.61 Transport Processes in the Environment
(Subject meets with 1.061)
Prereq: 1.060
G (Fall)
3-1-8
Meets with undergraduate subject 1.061. Graduate level includes additional homework in the form of reviews of relevant journal and practical articles. See description under subject 1.061.
H. M. Nepf

1.63J Fluid Dynamics
(Same subject as 2.21J)
Prereq: 18.085; 2.25 or permission of instructor.
G (Spring)
4-0-8 H-LEVEL Grad Credit
Fundamentals of fluid dynamics intrinsic to natural physical phenomena and/or engineering processes. Discusses a range of topics and advanced problem-solving techniques. Sample topics include brief review of basic laws of fluid motion, scaling and approximations, creeping flows, boundary layers in high-speed flows, steady and transient, similarity method of solution, buoyancy-driven convection in porous media, dispersion in steady or oscillatory flows, physics and mathematics of linearized instability, effects of shear and stratification. In alternate years, two of the following modules will be offered: I: Geophysical Fluid Dynamics of Coastal Waters, II: Capillary Phenomena, III: Non-Newtonian Fluids, IV: Flagellar Swimming.
T. R. Akylas, G. H. McKinley, R. Stocker

1.64 Physical Limnology
Prereq: 1.060, 1.061
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-6 H-LEVEL Grad Credit
Introduction to physical processes occuring in lakes and shallow surface water systems with emphasis on mechanisms affecting fate and transport. Topics include internal waves; differential heating and cooling; boundary mixing; turbulent mixing; influence of vegetation. Begins with a review of Navier-Stokes equation.
H. M. Nepf

1.66 Problems in Water Resources and Environmental Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Individual study in advanced topics as arranged between individual students and staff. Choice of subjects from theoretical, experimental, and practical phases of hydromechanics, hydraulic engineering, water resources, hydrology, and environmental engineering.
Staf

1.67 Sediment Transport and Coastal Processes
Prereq: 1.061, Coreq: 1.69
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
4-0-8 H-LEVEL Grad Credit
Emphasizes the quantitative description of the mechanics of sediment transport in steady and unsteady flows based on hydrodynamic principles. Equations of motion for particles in a turbulent flow, entrainment, bedload, and suspended load. Bedform mechanics, ripples, and dunes. Flow resistance and boundary-layer mechanics for waves and combined wave-current flows. Wave-induced longshore currents, longshore and on-shore sediment transport. Coastal protection. Basic theory of wave waves assumed known; contact instructor in late August if this presents a problem.
O. S. Madsen

1.685J Nonlinear Dynamics and Waves
(Same subject as 2.034J, 18.377J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.034J.
T. R. Akylas, R. R. Rosales

1.69 Introduction to Coastal Engineering
Prereq: 1.061
G (Fall)
4-0-8 H-LEVEL Grad Credit
O. S. Madsen

1.691J Surface Wave Dynamics
(Same subject as 2.064J)
Prereq: 1.060, 2.25, or 2.20; 1.131 or 18.075; or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
stresses and infragravity waves. Localization of nonlinear waves over random seabed.

T. R. Akylas

1.692) Ocean Wave Interaction with Ships and Offshore Energy Systems
(Same subject as 2.24j)
Prereq: 2.20, 18.085
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-8 H-LEVEL Grad Credit
See description under subject 2.24j.

P. D. Sclavounos

1.699) Special Projects in Oceanographic Engineering
(Same subject as 2.689I)
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 2.689j.

T. K. Stanton, Woods Hole Staff

HYDROLOGY AND WATER RESOURCE SYSTEMS

1.714 Surface Hydrology
Prereq: 1.070j
G (Spring)
3-0-9 H-LEVEL Grad Credit
Covers observations and theory of the physical processes involved in the hydrologic cycle. Processes considered are rainfall, infiltration, runoff generation, stream flow, evaporation, transpiration, and rainfall interception.

E. A. B. Eltahir

1.715 Environmental Data Analysis
Prereq: 1.010
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9
Covers probabilistic concepts and techniques that are useful for environmental data analysis. Topics include: random variables; hypothesis testing; linear regression; analysis of trends; space/time domain analysis; frequency domain analysis; simulation of random fields; Markovian processes; derived distributions; and stochastic differential equations. Problem sets emphasize environmental applications.

E. A. B. Eltahir

1.72 Groundwater Hydrology
Prereq: 1.061
G (Fall)
3-1-8 H-LEVEL Grad Credit
Fundamentals of subsurface flow and transport, emphasizing the role of groundwater in the hydrologic cycle, the relation of groundwater flow to geologic structure, and the management of contaminated groundwater. Topics include: Darcy equation, flow nets, mass conservation, the aquifer flow equation, heterogeneity and anisotropy, storage properties, regional circulation, unsaturated flow, recharge, stream-aquifer interaction, well hydraulics, flow through fractured rock, numerical models, groundwater quality, contaminant transport processes, dispersion, decay, and adsorption. Includes laboratory and computer demonstrations. Core requirement for Environmental and Geoenvironmental MEng program.

C. Harvey

1.721 Advanced Subsurface Hydrology
Prereq: 1.72, 18.075, permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

C. Harvey

1.723 Computational Methods for Flow in Porous Media
Prereq: Graduate Standing, permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

R. Juanes

1.725) Chemicals in the Environment: Fate and Transport
(Same subject as ESD.151J)
Prereq: Permission of instructor
G (Fall)
3-0-9
For Institute students in all departments interested in the behavior of chemicals in the environment. Subject covers the movement of chemicals through water, air, and soil, and also addresses their eventual fate. Physical transport, as well as chemical and biological sources and sinks, are discussed. Emphasis on anthropogenic chemicals, though in the context of pre-existing natural chemical cycles. Linkages to health effects, sources and control, and policy aspects. Core requirement for Environmental MEng program.

H. Hemond. P. Shanahan

1.731 Water Resource Systems
Prereq: 1.070 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Survey of simulation and optimization methods for management of water resources. Linear, nonlinear, and dynamic programming illustrated with case studies. Applications include reservoir and irrigation development, conjunctive use of surface and groundwater, capacity expansion, and sustainable resource development.

D. McLaughlin

AQUATIC SCIENCES, WATER QUALITY CONTROL, AND ENVIRONMENTAL MANAGEMENT

1.75 Limnology and Wetland Ecology
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Examines the major physical, chemical, and biological features of lakes and wetlands: basin geology, water budget, heat balance, thermal stratification, lake circulation, energy flow, biological communities, and cycles of major elements. Explores methodologies of limnology, including field methods and use of models, applications of modern sensor technology to lake and wetland studies and current issues in lake and wetland management.

H. F. Hemond
1.76 Aquatic Chemistry
Prereq: Chemistry (GIR) or 5.60
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Quantitative treatment of chemical processes in aquatic systems such as lakes, oceans, rivers, estuaries, groundwaters, and wastewaters. A brief review of chemical thermodynamics is followed by discussion of acid-base, precipitation-dissolution, coordination, and reduction-oxidation reactions. Emphasis is on equilibrium calculations as a tool for understanding the variables that govern the chemical composition of aquatic systems and the fate of inorganic pollutants.
J. Seewold

1.77 Water Quality Control
Prereq: 1.060
G (Spring)
3-0-9 H-LEVEL Grad Credit
Emphasis on mathematical models for predicting distribution and fate of effluents discharged into lakes, reservoirs, rivers, estuaries, and oceans. Focuses on formulating and structure of models as well as analytical and simple numerical solution techniques. Role of element cycles, such as oxygen, nitrogen, and phosphorus, as water quality indicators. Offshore outfalls and diffusion. Salinity intrusion in estuaries. Thermal stratification, eutrophication, and sedimentation processes in lakes and reservoirs. Core requirement for Environmental MEng program.
E. E. Adams

1.782 Environmental Engineering MEng Project
Prereq: Permission of instructor
G (Fall, IAP, Spring)
5-0-10 H-LEVEL Grad Credit
Core requirements for Environmental MEng program. Designed to teach about environmental engineering through the use of case studies, computer software tools, and seminars from industrial experts. Case studies provide basis for group project as well as individual thesis. Past case studies have included the MMR Superfund site on Cape Cod; restoration of the Florida Everglades; dredging of Boston Harbor; local watershed trading programs; appropriate wastewater treatment technology for Brazil; point-of-use water treatment for Nepal, Brownfields Development in Providence, RI, and water resource planning for the Island of Cyprus. Students must register for 1.782 for Fall term, IAP, and Spring term. Limited to Course 1 MEng students.
E. E. Adams

1.801J Environmental Law, Policy, and Economics: Pollution Prevention and Control
(Same subject as 11.021J, 17.393J)
(Subject meets with 1.811J, 11.630J, ESD.133J)
Prereq: None
U (Fall)
3-0-9 HASS
Introduction to important issues in contemporary environmental law, policy, and economics. Discusses the roles and interactions of Congress, federal agencies, state governments, and the courts in dealing with environmental problems. Topics include common law, administrative law, environmental impact assessments required by the National Environmental Policy Act, and legislation and court decisions dealing with air pollution, water pollution, the control of hazardous waste, pollution and accident prevention, community right-to-know, and environmental justice. Explores the role of science and economics in legal decisions, and economic incentives as an alternative or supplement to regulation. Analyzes pollution as an economic problem and a failure of markets. Introduction to basic legal skills: how to read and understand cases, regulation, and statutes; how to discover the current state of the law in a specific area; and how to take action toward resolution of environmental problems.
N. Ashford, C. C. Caldart

1.802J Regulation of Chemicals, Radiation, and Biotechnology
(Same subject as 11.631J, ESD.134J)
(Subject meets with 1.812J, 11.631J, ESD.134J)
Prereq: None
U (Spring)
3-0-9
Focuses on policy design and evaluation in the regulation of hazardous substances and processes. Includes risk assessment, industrial chemicals, pesticides, food contaminants, pharmaceuticals, radiation and radioactive wastes, product safety, workplace hazards, indoor air pollution, biotechnology, victims’ compensation, and administrative law. Health and economic consequences of regulation, as well as its potential to spur technological change, are discussed for each regulatory regime.
N. Ashford, C. C. Caldart

1.811J Environmental Law, Policy, and Economics: Pollution Prevention and Control
(Same subject as 11.630J, ESD.133J)
(Subject meets with 1.801J, 11.021J, 17.393J)
Prereq: Permission of instructor for undergraduates
G (Fall)
3-0-9 H-LEVEL Grad Credit
Reviews and analyzes federal and state regulation of air and water pollution and hazardous wastes. Analyzes pollution as an economic problem and the failure of markets. Emphasizes use of legal mechanisms and alternative approaches (such as economic incentives and voluntary approaches) to control pollution and to encourage chemical accident and pollution prevention. Focuses on the major federal legislation, the underlying administrative system, and the common law in analyzing environmental policy, economic consequences, and the role of the courts. Discusses classical pollutants and toxic industrial chemicals, community right-to-know, and environmental justice. Also provides an introduction to basic legal skills.
N. A. Ashford, C. C. Caldart

1.812J Regulation of Chemicals, Radiation, and Biotechnology
(Same subject as 11.631J, ESD.134J)
(Subject meets with 1.802J, 11.022J)
Prereq: Permission of instructor for undergraduates
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.802J.
N. A. Ashford, C. C. Caldart

1.813J Sustainability, Trade, and the Environment
(Same subject as 11.466J, 15.657J, ESD.137J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.137J.
N. A. Ashford

1.814J Industrial Ecology
(Same subject as 3.560J, ESD.123J)
Prereq: ESD.10 or 3.56
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject ESD.123J.
R. Kirchain, J. Clark, F. Field
1.817j Planning, Participation, and Consensus Building for Sustainable Development
(Same subject as 11.366j)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.366j.
D. Fairman

1.818j Sustainable Energy
(Same subject as 2.65j, 10.391j, 11.371j, 22.811j, ESD.166j)
(Subject meets with 2.650j, 10.291j, 22.081j)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 22.811j.
M. W. Golay, J. P. Freidberg

1.819j Design for Sustainability
(Same subject as 4.447j)
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit
Teaches thought processes and quantitative tools, including life cycle assessment (LCA) and the LEED rating system, applicable to integrated/whole building design with the goal of minimizing the waste of materials, energy and water. Readings, lectures, site visits, and homework encourage systematic thinking and interdisciplinary collaboration to make sustainable design a reality. Includes a team project of students’ choice, such as a conceptual design of a sustainable new building, a “green” retrofit, or a comparative LCA.
J. Connor, J. Ochsendorf, E. Adams

1.82 Problems in Environmental Microbiology and Chemistry
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Advanced topics in environmental microbiology, ecological genomics, microbial evolution and population genetics, oceanography, biogeochemical processes, environmental organic chemistry and aquatic chemistry. Includes independent study, seminar, laboratory, or field studies.

1.83 Environmental Organic Chemistry
(Subject meets with 1.831)
Prereq: 5.60, 18.03
G (Fall)
4-0-8 H-LEVEL Grad Credit
1.831 Environmental Organic Chemistry
(Subject meets with 1.83)
Prereq: 5.60, 18.03
G (Fall)
4-0-8
Focuses on the processes affecting organic compounds in the environment. Uses physical chemical properties to predict chemical transfers between environmental compartments (air, water, sediments, and biota). Uses molecular properties to estimate chemical, photochemical, and biochemical transformation rates. Resulting process models are combined to predict environmental concentrations (and related biological exposures) of anthropogenic and natural organic compounds.
P. M. Gschwend

1.85 Water and Wastewater Treatment Engineering
Prereq: 1.061, 1.61, or 1.725
G (Fall)
3-0-9
Staff

1.851j Water and Sanitation Infrastructure in Developing Countries
(Same subject as 11.479j)
Prereq: None
G (Spring)
Units arranged
Principles of infrastructure planning in developing countries, with a focus on appropriate and sustainable technologies for water and sanitation. Incorporates technical, socio-cultural, public health, and economic factors into the planning and design of water and sanitation systems. Upon completion, students are able to plan simple, yet reliable, water supply and sanitation systems for developing countries that are compatible with local customs and available human and material resources. Graduate and upper division students from any department who are interested in international development at the grassroots level are encouraged to participate in this interdisciplinary subject.
Consult Department Headquarters

1.86j Methods and Problems in Microbiology
(Subject meets with 7.492j, 20.445j)
Prereq: Permission of instructor or Coreq: 7.493
G (Fall)
3-0-9 [P/D/F] H-LEVEL Grad Credit
See description under subject 7.492j.
L. Samson, M. Polz

1.87j Microbial Genetics and Evolution
(Subject meets with 7.493j, 20.446j)
Prereq: 7.03, 7.05, 7.28 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 7.493j.
A. D. Grossman, E. Alm

1.88 Physical Ecology at the Microscale
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Designed for students in biological and chemical sciences seeking to understand the physical constraints of life at the microscale, and students in fluid mechanics and engineering who want to explore applications of physics and fluids to biology and ecology. Topics include random walks in biology, diffusion and mass exchange, Taylor dispersion, Stokes flow, swimming at low Reynolds numbers, motility of microorganisms, chemotaxis, mechanosensing, capture mechanisms, encounter rates, small scale turbulence. Emphasis is on application of physical and fluid dynamical principles to life at the microscale, in particular (but not limited to) aquatic systems.
R. Stocker

1.89 Environmental Microbiology
Prereq: 7.014
G (Fall)
3-0-9 H-LEVEL Grad Credit
A general introduction to the diverse roles of microorganisms in natural and artificial environments. Topics include: cellular architecture, energetics, and growth; evolution and gene flow; population and community dynamics; water and soil microbiology; biogeochemical cycling; and microorganisms in biodeterioration and bioremediation.
J. R. Thompson, M. F. Polz
SPECIAL STUDIES

1.961–1.966 Special Graduate Studies in Civil and Environmental Engineering
Prereq: Permission of instructor
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Graduate subjects taught experimentally; special subjects offered by visiting faculty; and seminars on topics of current interest. Consult Department Academic Programs Office

1.968 Graduate Studies in Civil and Environmental Engineering
Prereq: Permission of instructor
Units arranged
Can be repeated for credit
Graduate subjects taught experimentally; special subjects offered by visiting faculty; and seminars on topics of current interest. Consult Department Academic Programs Office

1.969 Graduate Studies in Civil and Environmental Engineering
Prereq: Permission of instructor
Units arranged
Can be repeated for credit
Graduate subjects taught experimentally; special subjects offered by visiting faculty; and seminars on topics of current interest. Consult Department Academic Programs Office

1.970—1.977 Special Graduate Studies in Civil and Environmental Engineering
Prereq: Permission of instructor
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Graduate subjects taught experimentally; special subjects offered by visiting faculty; and seminars on topics of current interest. Consult Department Academic Programs Office

1.978—1.979 Special Graduate Studies in Civil and Environmental Engineering
Prereq: Permission of instructor
Units arranged
Can be repeated for credit
Graduate subjects taught experimentally; special subjects offered by visiting faculty; and seminars on topics of current interest. Consult Department Academic Programs Office

1.981, 1.992 Special Undergraduate Studies in Civil and Environmental Engineering
Prereq: Permission of instructor
Units arranged
Can be repeated for credit
Subjects taught experimentally; special subjects offered by visiting faculty; and seminars on topics of current interest. Consult Department Academic Programs Office

1.982 Research in Civil and Environmental Engineering
Prereq: None
Units arranged [P/D/F]
Can be repeated for credit
For research assistants in the department, when assigned research is not used for thesis but is approved for academic credit. Consult Department Academic Programs Office

1.983 Teaching in Civil and Environmental Engineering
Prereq: None
Units arranged [P/D/F]
Can be repeated for credit
For teaching assistants to recognize the educational value derived from satisfactory performance of assigned duties and for other qualified students interested in teaching as a career. Consult Department Academic Programs Office

1.984 Teaching Experience in Environmental Engineering
Prereq: Permission of instructor
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
For qualified graduate students interested in teaching. Consult Department Academic Programs Office

1.991, 1.999 Undergraduate Studies in Civil and Environmental Engineering
Prereq: None
Units arranged
Can be repeated for credit
Individual study, research, or laboratory investigations under faculty supervision. Consult Department Academic Programs Office

1.993—1.995 Special Undergraduate Studies in Civil and Environmental Engineering
Prereq: Permission of instructor
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research leading to the writing of an SM, MEng, CE, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member. Consult Department Academic Programs Office

COURSE 1

10.EPW, 16.EPW, 20.EPW, 22.EPW
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 16.EPW, 22.EPW)

10.EPR, 16.EPR, 22.EPR
(Offered under: 1.EPR, 2.EPR, 3.EPR, 6.EPR, 16.EPR, 22.EPR)

10.EPE, 16.EPE, 22.EPE
(Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 16.EPE, 22.EPE)

S. Luperfoy

Information: O. S. Madsen
1. ThU Undergraduate Thesis
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Program of research leading to the writing of an
SB thesis; to be arranged by the student and
an appropriate MIT faculty member. Intended
for seniors. Student must submit an approved
thesis proposal to the Academic Programs Office
by the fifth week of the first term the student is
registered for thesis.
Consult Department Academic Programs Office

1. URG Research in Civil and Environmental
Engineering
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Individual research or laboratory study under
faculty supervision. Also opportunities in ongo-
ing research program.
Consult Department Academic Programs Office

Bachelor of Science in Civil Engineering/Course 1-C

General Institute Requirements (GIRs)                              Subjects
Science Requirement                                               6
Humanities, Arts, and Social Sciences Requirement                8
Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 1.00 or 1.018] and 18.03 in the Departmental Program]
Laboratory Requirement [can be satisfied by 1.101 and 1.102 in the Departmental Program]
Total GIR Subjects Required for SB Degree                        17

Communication Requirement
The program includes a Communication Requirement of 4 subjects:
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program
Subject names below are followed by credit units, and by prerequisites if any (corequisites in italics).
Required Subjects

Core
1.018J Ecology I: The Earth System, 12, REST, CI-M
1.020 Ecology II: Engineering for Sustainability, 12; Physics I (GIR), 18.03*
1.050 Engineering Mechanics I, 12; Physics I (GIR), Calculus II (GIR)
1.060 Engineering Mechanics II, 12; permission of instructor*
18.03 Differential Equations, 12, REST; Calculus II (GIR)
1.013 Senior Civil and Environmental Engineering Design, 12, CI-M; permission of instructor
1.00 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)
1.010 Uncertainty in Engineering, 12; Calculus II (GIR)

Civil Engineering
1.011 Project Evaluation, 9
1.035 Mechanics of Structures and Soils, 18; 1.050, 18.03
1.036 Structural and Geotechnical Engineering Design, 12; 1.035
1.041J Engineering Systems Design, 12; 1.011*

Laboratory
1.101 Introduction to Civil & Environmental Engineering Design I, 6, 1/2 LAB; 1.018, 1.050
1.102 Introduction to Civil & Environmental Engineering Design II, 6, 1/2 LAB; 1.060, permission of instructor

Restricted Electives

One advanced subject from the following list:
1.015J Design of Electromechanical Robotic Systems, 12, 1/2 LAB; 2.003, 2.671, 2.005*
1.032 Geomaterials and Geomechanics, 12; 1.010, 1.011, 1.035, 1.036
1.052J Mechanics of Structures, 12; 1.050*
1.054J Mechanics and Design of Concrete Structures, 12; 1.035
1.124J Foundations of Software and Computation for Simulation, 12; 1.00*
1.200J Transportation Systems Analysis: Performance and Optimization, 12; 1.010, permission of instructor
1.201J Transportation Systems Analysis: Demand and Economics, 12; permission of instructor
1.252J Urban Transportation Planning, 12; permission of instructor
1.260J Logistics Systems, 12; permission of instructor
1.573J Structural Mechanics, 12; 2.002*

Departmental Program Units That Also Satisfy the GIRs

Unrestricted Electives

(36)

Total Units Beyond the GIRs Required for SB Degree

No subject can be counted both as part of the 17-subject GIRs and as part of the 183 units required beyond
the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes
* Alternate prerequisites and corequisites are listed in the subject description.
For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule,
### Bachelor of Science in Environmental Engineering Science/Course 1-E

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement(4)</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [one subject can be satisfied by 1.802], 11.002, 11.122, or 14.01 in the Departmental Program]</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 1.018] and 18.03 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 1.101 and 1.102 in the Departmental Program]</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

**Communication Requirement**
The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**
Subject names below are followed by credit units, and by prerequisites if any (corequisites in italics).

#### Required Subjects

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.018J</td>
<td>Ecology I: The Earth System, 12, REST, CI-M</td>
<td>12</td>
</tr>
<tr>
<td>1.020</td>
<td>Ecology II: Engineering for Sustainability, 12; Physics I (GIR), 18.03*</td>
<td>12</td>
</tr>
<tr>
<td>1.050</td>
<td>Engineering Mechanics I, 12; Physics I (GIR), Calculus II (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>1.060</td>
<td>Engineering Mechanics II, 12; permission of instructor*</td>
<td>12</td>
</tr>
<tr>
<td>18.03</td>
<td>Differential Equations, 12, REST; Calculus II (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>1.070J</td>
<td>Introduction to Hydrology, 12, 1.060, 1.061, 1.105</td>
<td>12</td>
</tr>
<tr>
<td>1.071J</td>
<td>Environmental Chemistry and Biology, 12; Chemistry (GIR), Biology (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>1.072</td>
<td>Environmental Health Engineering, 12; 1.061*</td>
<td>12</td>
</tr>
<tr>
<td>1.075</td>
<td>Environmental Fluid Transport Processes and Hydrology Laboratory, 6, 1/2 LAB; 1.061, 1.070</td>
<td>6</td>
</tr>
<tr>
<td>1.107</td>
<td>Environmental Chemistry and Biology Laboratory, 6, 1/2 LAB; 1.080</td>
<td>6</td>
</tr>
<tr>
<td>1.080</td>
<td>Environmental Engineering Science</td>
<td>168</td>
</tr>
<tr>
<td>1.081</td>
<td>Economics and Public Policy</td>
<td>168</td>
</tr>
<tr>
<td>1.082</td>
<td>Laboratory</td>
<td>168</td>
</tr>
<tr>
<td>1.085</td>
<td>Restricted Elective</td>
<td>12</td>
</tr>
<tr>
<td>1.101</td>
<td>Introduction to Civil and Environmental Engineering Design I, 6, 1/2 LAB; 1.018, 1.050</td>
<td>12</td>
</tr>
<tr>
<td>1.102</td>
<td>Introduction to Civil and Environmental Engineering Design II, 6, 1/2 LAB; 1.060, permission of Instructor</td>
<td>12</td>
</tr>
</tbody>
</table>

**Unrestricted Electives**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.071J</td>
<td>Global Change Science, 12; 18.03, 5.60</td>
<td>12</td>
</tr>
<tr>
<td>1.64</td>
<td>Physical Limnology, 12; 1.060, 1.061</td>
<td>12</td>
</tr>
<tr>
<td>1.69</td>
<td>Introduction to Coastal Engineering, 12; 1.061</td>
<td>12</td>
</tr>
<tr>
<td>1.72</td>
<td>Groundwater Hydrology, 12; 1.061</td>
<td>12</td>
</tr>
<tr>
<td>1.734</td>
<td>Water Resource Systems, 12; 1.070*</td>
<td>12</td>
</tr>
<tr>
<td>1.77</td>
<td>Water Quality Control, 12; 1.060</td>
<td>12</td>
</tr>
<tr>
<td>1.83</td>
<td>Environmental Organic Chemistry, 12; 5.60, 18.03</td>
<td>12</td>
</tr>
<tr>
<td>1.89</td>
<td>Environmental Microbiology, 12; 5.14</td>
<td>12</td>
</tr>
<tr>
<td>1.89</td>
<td>Departmental Program Units That Also Satisfy the GIRs</td>
<td>(48)</td>
</tr>
<tr>
<td>1.101</td>
<td>Unrestricted Electives</td>
<td>48</td>
</tr>
</tbody>
</table>

**Total Units Beyond the GIRs Required for SB Degree**

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student's departmental program will count toward one or the other, but not both.

**Notes**

* Alternate prerequisites and corequisites are listed in the subject description.

* Any of the subjects that fulfill the Institute Chemistry Requirement is satisfactory, though 5.111 or 5.112 is recommended.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
Bachelor of Science as recommended by the Department of Civil and Environmental Engineering/Course 1-A

**General Institute Requirements (GIRs)**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 1.018] and 18.03 in the Departmental Program</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 1.101 and 1.102 in the Departmental Program]</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

**Communication Requirement**

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M). (1)

**PLUS Departmental Program**

Subject names below are followed by credit units, and by prerequisites if any (corequisites in italics).

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core</strong></td>
<td>84</td>
</tr>
<tr>
<td>1.018J Ecology I: The Earth System, 12; REST, CI-M</td>
<td></td>
</tr>
<tr>
<td>1.020 Ecology II: Engineering for Sustainability, 12; Physics I (GIR), 18.03*</td>
<td></td>
</tr>
<tr>
<td>1.050 Engineering Mechanics I, 12; Physics I (GIR), Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>1.060 Engineering Mechanics II, 12; permission of instructor*</td>
<td></td>
</tr>
<tr>
<td>18.03 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
</tbody>
</table>

One of the following two subjects:
- 1.00 Introduction to Computers and Engineering Problem Solving, 12; Calculus I (GIR)
- 1.010 Uncertainty in Engineering, 12; Calculus II (GIR)

<table>
<thead>
<tr>
<th>Laboratory</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.101 Introduction to Civil and Environmental Engineering Design I, 6, 1/2 LAB; 1.018, 1.050</td>
<td></td>
</tr>
<tr>
<td>1.102 Introduction to Civil and Environmental Engineering Design II, 6, 1/2 LAB; 1.060, permission of instructor</td>
<td></td>
</tr>
</tbody>
</table>

| Restricted Electives                                                           | 84    |

Students are required to take a coherent set of seven full subjects that meet a well-defined educational goal. These may be from within or outside the Department of Civil and Environmental Engineering. The electives must be approved by the student’s academic advisor and the undergraduate officer of the department.

<table>
<thead>
<tr>
<th>Department Program Units That Also Satisfy the GIRs</th>
<th>(36)</th>
</tr>
</thead>
</table>

| Unrestricted Electives | 48   |

**Total Units Beyond the GIRs Required for SB Degree**

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

**Notes**

* Alternate prerequisites and corequisites are listed in the subject description.

(1) To satisfy the CI-M component of the Communication Requirement, students must take the department’s two CI-M subjects (1.013 and 1.018) or, if appropriate, take one Course 1 CI-M subject and petition to substitute one CI-M from another science or engineering field. The outside CI-M must fit into the coherent program of electives approved by the student’s academic advisor.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
FRESHMAN YEAR
INTRODUCTORY SUBJECTS

2.00A Fundamentals of Engineering Design: Explore Space, Sea and Earth
   (Same subject as 16.00A)
   Prereq: Physics I (GIR), Calculus I (GIR)
   U (Spring)
   3-3-3

   Student teams formulate and complete space/ocean/sea design projects with weekly milestones. Introduces core engineering themes, principles, and modes of thinking. Specialized learning modules provide teams to focus on the knowledge required to complete their projects, such as machine elements, electronics, design process, visualization, and communication. Includes exercises in written and oral communication and team building. Examples of projects include designing a robotic spacecraft to clear the invasive growth; and exploration to search for the evidence of life on a moon of Jupiter, with scientists participating through teleoperation and supervisory control of robots. Enrollment limited; preference to freshmen.
   A. H. Techet, D. Newman

CORE UNDERGRADUATE SUBJECTS

2.001 Mechanics and Materials I
   Prereq: Physics I (GIR), Calculus II (GIR); Coreq: 18.03
   U (Fall, Spring)
   3-2-7 REST

   Introduction to statics and the mechanics of deformable solids. Emphasis on the three basic principles of equilibrium, geometric compatibility, and material behavior. Stress and its relation to force and moment; strain and its relation to displacement; linear elasticity with thermal expansion. Failure modes. Application to simple engineering structures such as rods, shafts, beams, and trusses. Application to biomechanics of natural materials and structures.
   K. J. Bathe, A. E. Hosoi, C. Livermore

2.002 Mechanics and Materials II
   Prereq: 2.001, Chemistry (GIR)
   U (Fall, Spring)
   3-3-6

   Introduces mechanical behavior of engineering materials, and the use of materials in mechanical design. Emphasizes the fundamentals of mechanical behavior of materials, as well as design with materials. Major topics: elasticity, plasticity, limit analysis, fatigue, fracture, and creep. Materials selection. Laboratory experiments involving projects related to materials in mechanical design.
   L. Anand, M. C. Boyce, K. Hamad-Schifferli, D. M. Parks

2.003J Dynamics and Control I
   (Same subject as 1.053J)
   Prereq: Physics I (GIR), 18.03
   U (Fall, Spring)
   4-1-7 REST

   N. G. Hadjiconstantinou, J. K. Vandiver, N. C. Makris, N. M. Patrikalakis, T. Peacock

2.004 Dynamics and Control II
   Prereq: 2.003, Physics II (GIR)
   U (Fall, Spring)
   4-2-6

   Modeling, analysis, and control of dynamic systems. System modeling: lumped parameter models of mechanical, electrical, and electromechanical systems; interconnection laws; actuators and sensors. Linear systems theory: linear algebra; Laplace transform; transfer functions, time response and frequency response, poles and zeros; block diagrams; solutions via analytical and numerical techniques; stability. Introduction to feedback control: closed-loop response; PID compensation; steady-state characteristics, root-locus design concepts, frequency-domain design concepts. Laboratory experiments and control design projects.

2.005 Thermal-Fluids Engineering I
   Prereq: Physics II (GIR), Calculus II (GIR); Coreq: 18.03
   U (Fall, Spring)
   5-0-7 REST

   J. G. Brisson, E. G. Cravalho, P. F. J. Lermusiaux, G. H. McKinley, E. N. Wang
2.006 Thermal-Fluids Engineering II
Prereq: 2.005, 18.03
U (Fall, Spring)
5-0-7

2.007 Design and Manufacturing I
Prereq: 2.001
U (Spring)
3-4-5
Develops students' competence and self-confidence as design engineers. Emphasis on the creative design process bolstered by application of physical laws. Instruction on how to complete projects on schedule and within budget. Robustness and manufacturability are emphasized. Subject relies on active learning via a major design-build project. Lecture topics include idea generation, estimation, concept selection, visual thinking, computer-aided design (CAD), mechanism design, machine elements, basic electronics, technical communication, and ethics. D. Frey, D. Gossard

2.008 Design and Manufacturing II
Prereq: 2.001; 2.007 or Coreq: 2.017; Coreq: 2.005
U (Fall, Spring)
3-3-6 1/2 Institute LAB
Integration of design, engineering, and management disciplines and practices for analysis and design of manufacturing enterprises. Emphasis is on the physics and stochastic nature of manufacturing processes and systems, and their effects on quality, rate, cost, and flexibility. Topics include process physics and control, design for manufacturing, and manufacturing systems. Group project requires design and fabrication of parts using mass-production and assembly methods to produce a product in quantity. Six units may be applied to the General Institute Lab Requirement. J.-H. Chun, M. L. Culpepper, E. M. Sachs, S. E. Sarma

2.009 The Product Engineering Process
Prereq: 2.001, 2.003, 2.005; 2.670 or 2.00B.
Senior standing or permission of instructor also required.
U (Fall)
3-3-6
Students develop an understanding of product development phases and experience working in teams to design and construct high-quality product prototypes. Design process learned is placed into a broader development context. Primary goals are to improve ability to reason about design alternatives and apply modeling techniques appropriate for different development phases; understand how to gather and process customer information and transform it into engineering specifications; and use teamwork to resolve the challenges in designing and building a substantive product prototype. Instruction and practice in oral communication provided. D. R. Wallace

2.012J Mechanics of Structures
(Same subject as 1.052J)
Prereq: 2.001 or 1.050
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
4-1-7
Mechanics of materials, elastic and plastic behavior, fatigue, fracture. Analytical and computational techniques to assess response of complex structures under static loads (beams, shafts, trusses, frames, cables). Energy methods to explain the concepts of equilibrium, stability, principle of virtual work, and to develop approximate methods for deflections and buckling loads. Examples using MATLAB and PC versions of commercial finite element codes. Mechanical, ocean and civil engineering applications. T. Wierzbicki, H. Schmidt

2.016 Hydrodynamics
Prereq: Physics II (GIR), 18.03
U (Fall)
4-2-6
Principles of conservation of mass, momentum and energy in fluid mechanics. Basic geophysical fluid mechanics, including the effects of salinity, temperature, and density; heat balance in the ocean; large scale flows. Hydrostatics. Linear free surface waves, wave forces on floating and submerged structures. Added mass, lift and drag forces. Introduction to ocean acoustics; sound propagation and refraction. Sonar equation. Laboratory sessions in wave propagation, lift and drag forces on submerged bodies, and sound propagation. A. H. Techet

2.017J Design of Electromechanical Robotic Systems
(Same subject as 1.015J)
Prereq: 2.003J; Coreq: 2.005 or 2.016; 2.671
U (Fall)
3-4-5 1/2 Institute LAB
Design, construction, and testing of field robotic systems, through team projects with each student responsible for a specific subsystem. Projects focus on electronics, instrumentation, and machine elements. Design for operation in uncertain conditions is a focus point, with ocean waves and marine structures as a central theme. Basic statistics, linear systems, Fourier transforms, random processes, spectra and extreme events with applications in design. Lectures on ethics in engineering practice included. Enrollment may be limited due to laboratory capacity. F. S. Hover

2.019 Design of Ocean Systems
Prereq: 2.001; 2.003J; 2.005 or 2.016. Senior standing or permission of instructor also required.
U (Spring)
3-3-6
Complete cycle of designing an ocean system using computational design tools for the conceptual and preliminary design stages. Team projects assigned, with each student responsible for a specific subsystem. Lectures cover hydrodynamics; structures; power and thermal aspects of ocean vehicles, environment, materials, and construction for ocean use; generation and evaluation of design alternatives. Focus on innovative design concepts chosen from high-speed ships, submersibles, autonomous vehicles, and floating and submerged deep-water offshore platforms. Lectures on ethics in engineering practice included. Instruction and practice in oral and written communication provided. C. Chryssostomidis, M. S. Triantafyllou

DYNAMICS AND ACOUSTICS

2.032 Dynamics
Prereq: 2.003J
G (Fall)
3-0-9 H-LEVEL Grad Credit
systems. Introduction to wave propagation in continuous systems.
T. R. Akylas, T. Peacock

2.034| Nonlinear Dynamics and Waves
(Same subject as 1.685J, 18.377J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

A unified treatment of nonlinear oscillations and wave phenomena with applications to mechanical, optical, geophysical, fluid, electrical and flow-structure interaction problems. Nonlinear free and forced vibrations; nonlinear resonances; self-excited oscillations; lock-in phenomena. Nonlinear dispersive and nondispersive waves; resonant wave interactions; propagation of wave pulses and nonlinear Schrodinger equation. Nonlinear long waves and breaking; theory of characteristics; the Korteweg-de Vries equation; solitons and solitary wave interactions. Stability of shear flows. Some topics and applications may vary from year to year.
T. R. Akylas, R. R. Rosales

2.035 Special Topics in Mathematics with Applications
Prereq: Physics II (GIR), 18.03 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-3 H-LEVEL Grad Credit

Introduction to a selection of mathematical topics that are not covered in traditional mechanical engineering curricula, such as differential geometry, integral geometry, discrete computational geometry, graph theory, optimization techniques, calculus of variations and linear algebra. Emphasis on basic ideas and on applications in mechanical engineering. Selection will change every year.
R. C. Abeyaratne, S. E. Sarma

2.036| Nonlinear Dynamics and Chaos
(Same subject as 18.385J)
Prereq: 18.03 or 18.034
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 18.385J.
Information: R. R. Rosales

2.037| Advanced Nonlinear Dynamics and Chaos
(Same subject as 18.386J)
Prereq: 18.385/2.036 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 18.386J.
Information: R. R. Rosales

2.038| The Art of Approximation in Science and Engineering
(Same subject as 6.055J)
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
3-0-9

See description under subject 6.055J.
S. Mahajan, R. Abeyaratne

2.050| Nonlinear Dynamics I: Chaos
(Same subject as 12.006J, 18.353J)
Prereq: 18.03 or 18.034; Physics II (GIR)
U (Fall)
3-0-9

See description under subject 12.006J.
T. Peacock

2.06| Mechanical Vibration
Prereq: 2.003J
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
4-0-8

Concepts of mechanical vibration, including free and forced vibration of single- and multi-degree of freedom systems. Modal analysis and matrix formulation of vibration problems. Approximate solution techniques. Vibration and modal analysis of continuous systems: beams, rods, and strings. Introduction to the response of linear systems to random excitation. Numerous examples and applications of vibration measurement and analysis, including vibration isolation and dynamic absorbers, ships, offshore structures, engines, and rotating machinery.
J. K. Vandiver

2.060| Structural Dynamics and Vibrations
(Same subject as 1.581J, 16.221J)
(Subject meets with 1.058)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit

See description under subject 1.581J.
E. Kausel, J. K. Vandiver

2.062| Wave Propagation
(Same subject as 1.138J, 18.376J)
Prereq: 2.003J, 18.075
G (Spring)
3-0-9 H-LEVEL Grad Credit

T. R. Akylas, R. R. Rosales

2.064| Surface Wave Dynamics
(Same subject as 1.691J)
Prereq: 1.060, 2.25, or 2.20; 1.131 or 18.075; or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 1.691J.
T. R. Akylas

2.065| Acoustics and Sensing
(Subject meets with 2.066)
Prereq: 2.003J, 6.003, 8.03, or 16.03
U (Spring)
3-0-9

2.066| Acoustics and Sensing
(Subject meets with 2.065)
Prereq: 2.003J, 6.003, 8.03, 16.03, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Introduces the fundamental concepts of acoustics and sensing with waves. Provides a unified theoretical approach to the physics of image formation through scattering and wave propagation in sensing. The linear and nonlinear acoustic wave equation, sources of sound, including musical instruments. Reflection, refraction, transmission and absorption. Bearing and range estimation by sensor array processing, beamforming, matched filtering, and focusing. Diffraction, bandwidth, ambient noise and reverberation limitations. Scattering from objects, surfaces and volumes by Green’s Theorem. Forward scatter, shadows, Babinet’s principle, extinction and attenuation. Ray tracing
SOLID MECHANICS AND MATERIALS

2.071 Mechanics of Solid Materials
Prereq: 2.002
G (Spring)
4-0-8 H-LEVEL Grad Credit

Fundamentals of solid mechanics applied to the mechanical behavior of engineering materials. Kinematics of deformation, stress, and balance principles. Isotropic linear elasticity and isotropic linear thermal elasticity. Variational and energy methods. Linear viscoelasticity. Small-strain elastic-plastic deformation. Mechanics of large deformation; nonlinear hyperelastic material behavior. Foundations and methods of deformable-solid mechanics, including relevant applications. Provides base for further study and specialization within solid mechanics, including continuum mechanics, computational mechanics (e.g., finite-element methods), plasticity, fracture mechanics, structural mechanics, and nonlinear behavior of materials.
L. Anand, M. C. Boyce, D. M. Parks

2.072 Mechanics of Continuous Media
Prereq: 2.071
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Principles and applications of continuum mechanics. Kinematics of deformation. Thermomechanical conservation laws. Stress and strain measures. Constitutive equations including some examples of their microscopic basis. Solution of some basic problems for various materials as relevant in materials science, fluid dynamics, and structural analysis. Inherently nonlinear phenomena in continuum mechanics. Variational principles.
L. Anand

2.073 Solid Mechanics: Plasticity and Inelastic Deformation
Prereq: 2.071
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Physical basis of plastic/inelastic deformation of solids; metals, polymers, granular/rock-like materials. Continuum constitutive models for small and large deformation of elastic-(visco)plastic solids. Analytical and numerical solution of selected boundary value problems. Applications to deformation processing of metals.
L. Anand, M. C. Boyce, D. M. Parks

2.074 Solid Mechanics: Elasticity
Prereq: 2.002, Coreq: 18.03
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

D. M. Parks

2.075 Advanced Mechanical Behavior of Materials
Prereq: 2.071, Chemistry (GIR)
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Fundamentals of the mechanical behavior of engineering materials and their uses in structural and design-related applications is presented, starting from a mechanistic point of view to arrive at phenomenological forms of constitutive behavior for deformation and fracture. Problems involving elasticity, plasticity, creep, visco-elasticity, rubber elasticity and monotonic and cyclic fracture discussed.
M. C. Boyce, D. M. Parks

2.080J Structural Mechanics
(Same subject as 1.573)
Prereq: 2.002 or 2.012
G (Fall)
4-0-8 H-LEVEL Grad Credit

Fundamental concepts of structural mechanics with applications to marine, civil, and mechanical structures. Residual stresses. Thermal effects. Analysis of beams, columns, tensioned beams, trusses, frames, arches, cables, and shafts of general shape and material, including composites. Elastic buckling of columns. Exact and approximate methods, energy methods, principle of virtual work, introduction to computational structural mechanics. Examples from civil, mechanical, offshore, and ship structures.
T. Wierzbicki, J. J. Connor, Jr., H. Schmidt

2.081J Plates and Shells
(Same subject as 16.230J)
Prereq: 2.074, 2.080J, or 16.21
G (Spring)
3-0-3 H-LEVEL Grad Credit

T. Wierzbicki

2.082 Ship Structural Analysis and Design
Prereq: 2.081J, 2.701
G (Spring)
3-0-3 H-LEVEL Grad Credit

Design application of analysis developed in 2.081J. Ship longitudinal strength and hull primary stresses. Ship structural design concepts. Design limit states including plate bending, column and panel buckling, panel ultimate strength, and plastic analysis. Matrix stiffness, and introduction to finite element analysis. Computer projects on the structural design of a midship module. Taught during second half of term.
R. S. McCord, T. Wierzbicki

2.084J Structural Mechanics in Nuclear Power Technology
(Same subject as 1.56J, 22.314J)
Prereq: 2.001 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 22.314J.
M. S. Kazimi, O. Buyukozturk

2.085 Structural Impact
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
2-0-4 H-LEVEL Grad Credit

Propagation of 1-D elastic waves in rods, geometrical and material dispersion. Plane, Rayleigh surface, and 3-D waves. Wave reflection and interaction. 1-D plastic waves. Response
of plates and shells to high-intensity loads. Dynamic plasticity and fracture. Damage of structures subjected to impulsive and impact loads. Topics in crashworthiness. Taught second half of the term. Students can take 2.707 in first half of the term.

T. Wierzbicki

**COMPUTATIONAL ENGINEERING**

2.086 Numerical Computation for Mechanical Engineers
Prereq: 2.001, 2.003; Coreq: 2.005
U (Spring)
3-3-6

Introduction to programming concepts including variable types, data structures, flow control. Numerical methods relevant to MechE including approximation (interpolation, statistical regression); integration; solution of linear and nonlinear equations, eigenproblems, ordinary differential equations, partial differential equations. Deterministic and probabilistic methods. Examples from MechE including lumped and continuum models from solid and fluid mechanics, heat transfer; dynamics and control; design and manufacturing. Assignments requiring MATLAB programming.

N. Hadjiconstantinou, A. Patera, D. Frey

2.089J Computational Geometry
(Same subject as 1.128J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit


N. M. Patrikalakis, D. C. Gossard

2.091J Software and Computation for Simulation
(Same subject as 1.124J, ESD.51J)
Prereq: 1.00 or knowledge of an object-oriented language
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 1.124J.
J. R. Williams

2.092 Finite Element Analysis of Solids and Fluids I
(Subject meets with 2.093)
Prereq: 2.001, 2.003
U (Fall)
3-0-9

2.093 Finite Element Analysis of Solids and Fluids I
(Subject meets with 2.092)
Prereq: 2.001, 2.003
G (Fall)
3-0-9 H-LEVEL Grad Credit

Finite element methods for analysis of steady-state and transient problems in solid, structural, fluid mechanics, and heat transfer. Presents finite element methods and solution procedures for linear and nonlinear analyses using largely physical arguments. Demonstrates finite element analyses. Homework involves use of an existing general purpose finite element analysis program. Term project required for graduate students. Modeling of problems and interpretation of numerical results.

K. J. Bathe

2.094 Finite Element Analysis of Solids and Fluids II
Prereq: 2.001
G (Spring)
3-0-9 H-LEVEL Grad Credit

Presents finite element theory and methods for general linear and nonlinear analyses. Reliable and effective finite element methods and their applications to solution of general problems in solid, structural and fluid mechanics, heat and mass transfer, and multiphysics problems. Formulation of governing continuum mechanics equations, conservation laws, virtual work, and variational principles for finite element solutions. Discretization of governing equations using finite element methods stability, accuracy and convergence of methods. Solution of central problems and a term project using an existing general purpose finite element analysis program.

K. J. Bathe

2.095 Molecular Modeling and Simulation for Mechanics
Prereq: 2.002, 2.006, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit


N. G. Hadjiconstantinou

2.096J Introduction to Numerical Simulation
(Same subject as 6.336J, 16.910J)
Prereq: 18.03 or 18.06
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 6.336J.
L. Daniel, J. K. White

2.097J Numerical Methods for Partial Differential Equations
(Same subject as 6.339J, 16.920J)
Prereq: 18.03 or 18.06
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 16.920J.
J. Peraire, A. T. Patera, J. K. White

2.099J Computational Mechanics of Materials
(Same subject as 16.225J)
Prereq: Permission of instructor, programming in either C++, C, or Fortran
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-3-6 H-LEVEL Grad Credit

See description under subject 16.225J.
R. Radovitzky

**SYSTEM DYNAMICS AND CONTROL**

2.110J Information, Entropy and Computation
(Same subject as 6.050J)
Prereq: Physics I (GIR)
U (Spring)
4-0-5

See description under subject 6.050J.
P. Penfield, Jr., S. Lloyd
2.111 Quantum Computation
(Same subject as 18.435J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 18.435J.
E. Farhi, S. Lloyd, P. Shor

2.12 Introduction to Robotics
Prereq: 2.004
U (Fall)
3-2-7
Overview of robot mechanisms, dynamics, and intelligent controls. Planar and spatial kinematics, motion planning; mechanism design for manipulators and mobile robots, multi-rigid-body dynamics, 3-D graphic simulation; control design, actuators, sensors; wireless networking, task modeling, human-machine interface, and imbedded software. Weekly laboratories for experience with servo drives, real-time control, and embedded software. Group term project requires design and fabrication of robotic systems.
H. Asada, J. J. Leonard

2.131 Advanced Instrumentation and Measurement
Prereq: Permission of instructor
G (Spring)
3-6-3 H-LEVEL Grad Credit
Provides training in advanced instrumentation and measurement techniques. Topics include system level design, fabrication and evaluation with emphasis on systems involving concepts and technology from mechanics, optics, electronics, chemistry and biology. Simulation, modeling and design software. Use of a wide range of instruments/techniques (e.g., scanning electron microscope, dynamic signal/system analyzer, impedance analyzer, laser interferometer) and fabrication/machining methods (e.g., laser micro-machining, stereo lithography, computer controlled turning and machining centers). Theory and practice of both linear and nonlinear system identification techniques. No final exam.
I. W. Hunter

2.14 Analysis and Design of Feedback Control Systems
(Subject meets with 2.140)
Prereq: 2.004
U (Spring)
3-2-7
Develops the fundamentals of feedback control using linear transfer function system models. Analysis in time and frequency domains. Design in the s-plane (root locus) and in the frequency domain (loop shaping). Describing functions for stability of certain non-linear systems. Extension to state variable systems and multivariable control with observers. Discrete and Digital hybrid systems and use of z-plane design. Extended design case studies and capstone group projects. Graduate students are expected to complete additional assignments.
D. Rowell, D. L. Trumper, K. Youcef-Toumi

2.151 Advanced System Dynamics and Control
Prereq: 2.004, 18.06
G (Fall)
4-0-8 H-LEVEL Grad Credit
Analytical and graphical descriptions of state-determined dynamic physical systems; time and frequency domain representations; system characteristics—controllability, observability, stability; linear and nonlinear system responses. Modification of system characteristics using feedback. State observers, Kalman filters. Modeling/performance trade-offs in control system design. Emphasis on application of techniques to physical systems.
K. Youcef-Toumi, N. Hogan, D. Rowell

2.152 Nonlinear Control System Design
Prereq: 2.151, 6.241, 16.31, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
J.-J. E. Slotine

2.154 Maneuvering and Control of Surface and Underwater Vehicles
Prereq: 2.22
G (Fall)
3-0-9 H-LEVEL Grad Credit
M. S. Triantafyllou

2.160 Identification, Estimation, and Learning
Prereq: 2.151
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Provides a broad theoretical basis for system identification, estimation, and learning. Least squares estimation and its convergence properties, Kalman filter and extended Kalman filter, noise dynamics and system representation, function approximation theory, neural nets, radial basis functions, wavelets, Volterra expansions, informative data sets, persistent excitation, asymptotic variance, central limit theorems, model structure selection, system
order estimate, maximum likelihood, unbiased estimates, Cramer-Rao lower bound, Kullback-Leibler information distance, Akaike’s information criterion, experiment design, and model validation.

H. Asada, J.-J. E. Slotine

2.161 Signal Processing: Continuous and Discrete
Prereq: Knowledge of system dynamics
G (Fall)
3-0-9 H-LEVEL Grad Credit

Provides a solid theoretical foundation for the analysis and processing of experimental data, and real-time experimental control methods. Includes spectral analysis, filter design, system identification, simulation in continuous and discrete-time domains. Emphasis on practical problems with laboratory exercises.

D. Rowell

2.165 Robotics
Prereq: 2.151 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit


J.-J. E. Slotine, H. Asada

2.166 Probabilistic Techniques for Mobile Robotics
Prereq: 6.041 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-1-8 H-LEVEL Grad Credit

Theory and application of probabilistic techniques for autonomous mobile robotics. Topics include probabilistic state estimation and decision making for mobile robots; stochastic representations of the environment; dynamic models and sensor models for mobile robots; algorithms for mapping and localization; planning and control in the presence of uncertainty; cooperative operation of multiple mobile robots; mobile sensor networks; application to autonomous marine (underwater and floating), ground, and air vehicles.

J. J. Leonard

2.167 Hands-On Marine Robotics
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Direct experience in developing marine robotic systems, from conceptualization and design through manufacture and testing. The class consists of a weekly seminar with readings and discussions, and significant outside work on student projects, culminating in a written report each term. Seminar topics include tools for unmanned marine work and their history, analysis of mission requirements, conceptual design and modeling of systems, experiments and proofs of concept, and project pacing and time management. A total of up to 12 hours credit may be taken over one or two terms; seminar topics repeat yearly.

F. S. Hover

2.168 Analysis, Design, and Control of Automated Equipment
Prereq: 2.14, Coreq: 2.151
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Emphasizes a systems approach to equipment selection and/or design. Provides exposure to selected industrial automation practices and develops the ability to select appropriate automation methods. Fundamental building blocks are: system kinematics and dynamics, modeling, measurement and actuation, uncertainty, control-system theory. System performance limitation due to hardware/software. Use of feedback control system to meet equipment performance specifications. Use of case studies from industrial applications.

K. Youcef-Toumi, D. E. Hardt

2.171 Analysis and Design of Digital Control Systems
Prereq: 2.14, 2.151, or permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-3-6 H-LEVEL Grad Credit

A comprehensive introduction to digital control system design, reinforced with hands-on laboratory experiences. Major topics include discrete-time system theory and analytical tools; design of digital control systems via approximation from continuous time; direct discrete-time design; loop-shaping design for performance and robustness; state-space design; observers and state-feedback; quantization and other nonlinear effects; implementation issues. Laboratory experiences and design projects connect theory with practice.

D. L. Trumper

2.183 Biomechanics and Neural Control of Movement
(Subject meets with 2.184)
Prereq: 2.004 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

2.184 Biomechanics and Neural Control of Movement
(Subject meets with 2.183)
Prereq: 2.004 or permission of instructor
U (Spring)
3-0-9

Quantitative knowledge of human movement behavior is important in a growing number of engineering applications (medical & rehabilitation technology, athletic & military equipment, human-computer interaction, vehicle performance, etc.). Presents a quantitative, model-based description of how biomechanical and neural factors interact in human sensory-motor behavior, focusing mainly on the upper limbs. Students survey recent literature on how motor behavior is controlled, comparing biological and robotic approaches to similar tasks. Topics may include a review of relevant neural, muscular and skeletal physiology, neural feedback and “equilibrium-point” theories, co-contraction strategies, impedance control, kinematic redundancy, optimization, intermittency, contact tasks and tool use. Students taking the graduate version will complete additional assignments.

N. Hogan

FLUID MECHANICS AND COMBUSTION

2.20 Marine Hydrodynamics
Prereq: 2.006, 2.016, or 1.060
G (Fall)
4-1-7 H-LEVEL Grad Credit

The fundamentals of fluid mechanics are developed in the context of naval architecture and ocean science and engineering. Transport theorem and conservation principles. Navier-Stokes’ equation. Dimensional analysis. Ideal and potential flows. Vorticity and Kelvin’s theorem. Hydrodynamic forces in potential flow, D’Alembert’s paradox, added-mass, slender-body theory. Viscous-fluid flow, laminar and turbulent boundary layers. Model testing, scaling laws. Application of potential theory to surface waves, energy transport, wave/body forces, linen-
2.24 Ocean Wave Interaction with Ships and Offshore Energy Systems
(Same subject as 1.692J)
Prereq: 2.20, 18.085
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
4-0-8 H-LEVEL Grad Credit
Surface wave theory, conservation laws and boundary conditions, properties of regular surface waves and random ocean waves. Linearized theory of floating body dynamics, kinematic and dynamic free surface conditions, body boundary conditions. Simple harmonic motions. Diffraction and radiation problems, added mass and damping matrices. General reciprocity identities on diffraction and radiation. Ship wave resistance theory, Kelvin wake physics, ship seakeeping in regular and random waves. Discusses point wave energy absorbers, beam sea and head-sea devices, oscillating water column device and Well’s turbine. Discusses offshore floating energy systems and their interaction with ambient waves, current and wind, including oil and gas platforms, Liquefied Natural Gas (LNG) vessels and floating wind turbines. Work drawn from real world applications.

M. S. Triantafyllou

2.25 Advanced Fluid Mechanics
Prereq: 2.006; Coreq: 18.075 or 18.085
G (Fall)
4-0-8 H-LEVEL Grad Credit
A. F. Ghoniem, A. E. Hosoi, G. H. McKinley, A. T. Patera

2.26 Compressible Fluid Dynamics
Prereq: 2.006
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
2-0-4 H-LEVEL Grad Credit
Fundamental concepts and results for the compressible flow of gases. Topics include thermodynamics, appropriate conservation laws; propagation of disturbances; isotropic flows; normal shock wave relations, oblique shock waves, weak and strong shocks, and shock wave structure; compressible flows in ducts with area changes, friction, or heat addition; heat transfer to high speed flows; unsteady compressible flows, Riemann invariants, and piston and shock tube problems; steady 2-D supersonic flow, Prandtl-Meyer function. Emphasis on thermodynamic processes, physical understanding of the phenomena and basic analytical techniques.
J. H. Lienhard

2.27 Turbulent and Separated Flows
Prereq: 2.20 or 2.25; 18.075
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Governing equations, and statistical and dynamical theories of turbulence. Isotropic homogeneous turbulence, near wall turbulence, effects of free surface and surfactants and moving body boundary. Direct numerical simulations, large eddy simulations and sub-grid scale modeling, Reynolds-Averaged Navier-Stokes (RANS) equations and RANS turbulence models. Flow instability and transitions, almost parallel flows and inviscid and viscous instabilities. Laminar and turbulent separation, expansion flows, separated flows past bluff and streamlined bodies; flow induced vibrations.

2.28 Fundamentals and Applications of Combustion
Prereq: 2.006
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
A. F. Ghoniem

2.29 Numerical Fluid Mechanics
Prereq: 2.006, 2.016, 2.20, or 2.25; 18.075
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
4-0-8 H-LEVEL Grad Credit
Introductory MATLAB. Introduction to numerical methods: number representation and errors, interpolation, differentiation, integration, systems of linear equations, Fourier interpolation and transforms. Fluid flow modeling, the Navier-Stokes equations and its approximations. Differential equations: partial and ordinary differential equations, elliptic, parabolic and
2.341J Macromolecular Hydrodynamics

(Same subject as 10.531J)
Prereq: 2.25, 10.301, or permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit
See description under subject 10.531J.
R. C. Armstrong, G. H. McKinley

MEMS AND NANO TECHNOLOGY

2.37 Molecular Mechanics

(Subject meets with 2.370)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
4-0-8 H-LEVEL Grad Credit
2.370 Molecular Mechanics

(Subject meets with 2.37)
Prereq: 2.001; Chemistry (GIR)
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
4-0-8
Introduction to the fundamentals of molecular modeling in engineering, with emphasis on mechanical engineering applications. Statistical mechanics and its connection to engineering thermodynamics. Molecular origin of macroscopic descriptions and constitutive relations for equilibrium and non-equilibrium behavior. Limitations of macroscopic descriptions. Discussion of molecular approaches to modern nanoscale engineering problems. Introduction to molecular simulation. Graduate students are required to complete additional assignments with stronger analytical content.
N. G. Hadjiconstantinou

2.371 Microscale Fluid Mechanics

Prereq: 2.005; Physics II (GIR)
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9
Introduction to the manipulation of liquids in microscale conduits. Emphasizes both pressure-based and electrochemical driving forces, including electro-osmosis and dielectrophoresis. Major topics include viscosity, diffusion, mixing, electrokinetics and the Debye layer, pumps, fluid polarization, and particle behavior in pressure-based and charged environments.

P. F. J. Lermusiaux

2.372J Design and Fabrication of MEMS

(Same subject as 6.777J)
Prereq: 6.003 or 2.004, Physics II (GIR); or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.777J.
C. Livermore, J. Voldman

2.373J Materials and Processes for Microelectromechanical Devices and Systems

(Same subject as 3.48J, 6.778J, 10.584J, 16.288J)
Prereq: 6.152J/3.155J; permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 3.48J.
L. Anand, K. F. Jensen, M. A. Schmidt, C. V. Thompson, B. L. Wardle

2.391J Nanostructure Fabrication

(Same subject as 6.781J)
Prereq: 6.152, 6.161, or 2.710; or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
See description under subject 6.781J.
H. I. Smith, G. Barbastathis, K. K. Berggren

THERMODYNAMICS

2.41 Advanced Thermal Fluids Engineering

Prereq: 2.006
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
4-0-8
Examines current and future energy conversion systems. Introduction to thermochemistry and thermal radiation heat transfer. Introduction to the design of turbomachinery and the design of thermal-fluids systems. Analysis of various energy conversion systems including Rankine, Brayton, Otto, and Diesel. Special attention to combined cycle plants and fuel cells. Introduction to refrigeration plants. Applications include stationary plants and mobile plants. Consideration of pollution, environmental, and policy issues.
E. G. Cravalho

2.42 General Thermodynamics

Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
General foundations of thermodynamics from an entropy point of view, entropy generation and transfer in complex systems. Definitions of work, energy, stable equilibrium, available energy, entropy, thermodynamic potential, and interactions other than work (nonwork, heat, mass transfer). Applications to properties of materials, bulk flow, energy conversion, chemical equilibrium, combustion, and industrial manufacturing.
E. G. Cravalho

HEAT AND MASS TRANSFER

2.500 Desalination and Water Purification

Prereq: 2.006, 1.020, 10.302, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduces the fundamental science and technology of desalinating water to overcome water scarcity and ensure sustainable water supplies. Covers basic water chemistry, flash evaporation, reverse osmosis and membrane engineering, electrodialysis, nanofiltration, solar desalination, energy efficiency of desalination systems, fouling and scaling, environmental impacts, and economics of desalination systems. Open to upper-class undergraduates.
J. H. Lienhard, M. Bolaban

2.51 Intermediate Heat and Mass Transfer

Prereq: 2.006 or permission of instructor
U (Fall)
3-0-9
Analysis, modeling, and design of heat and mass transfer processes with application to common technologies. Unsteady heat conduction in one or more dimensions, steady conduction in multidimensional configurations, numerical simulation; forced convection in laminar and turbulent flows; natural convection in internal and external configurations; phase change heat transfer; thermal radiation, black bodies, grey radiation networks, spectral and solar radiation; mass transfer at low rates, evaporation.
J. H. Lienhard, B. Miki
2.52 Modeling and Approximation of Thermal Processes  
Prereq: 2.51  
Acad Year 2009–2010: G (Fall)  
Acad Year 2010–2011: Not offered  
3-0-9 H-LEVEL Grad Credit  
Focuses on teaching students how to model thermal transport processes in typical engineering systems such as those found in manufacturing, machinery, and energy technologies. Subject is divided into successive modules that cover basic modeling tactics for particular modes of transport, including steady and unsteady heat conduction, convection, multiphase flow processes, and thermal radiation. Subject includes a creative design project executed by the students.  
L. R. Glicksman

2.55 Advanced Heat and Mass Transfer  
Prereq: 2.51  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Advanced treatment of fundamental aspects of heat and mass transport. Topics covered include: diffusion kinetics, conservation laws, laminar and turbulent convection, mass transfer including phase change or heterogeneous reactions, and basic thermal radiation. Problems and examples include theory and applications drawn from a spectrum of engineering design and manufacturing problems.  
B. Mikić, J. H. Lienhard

2.56 Conduction and Change of Phase Heat Transfer  
Prereq: 2.51, Coreq: 18.075  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
B. Mikić

2.57 Nano-to-Macro Transport Processes  
(Subject meets with 2.570)  
Prereq: 2.005 or permission of instructor  
Acad Year 2009–2010: G (Spring)  
Acad Year 2010–2011: Not offered  
3-0-9 H-LEVEL Grad Credit  
Parallel treatments of photons, electrons, phonons, and molecules as energy carriers; aiming at a fundamental understanding of descriptive tools for energy and heat transport processes, from nanoscale to macroscale. Topics include energy levels; statistical behavior and internal energy; energy transport in the forms of waves and particles; scattering and heat generation processes; Boltzmann equation and derivation of classical laws; and deviation from classical laws at nanoscale and their appropriate descriptions. Applications in nanotechnology and microtechnology. Students taking the graduate version complete additional assignments.  
G. Chen

2.58] Radiative Transfer  
(Same subject as 10.74a)  
Prereq: 2.51, 10.302, or permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Principles of thermal radiation and their application to engineering heat and photon transfer problems. Quantum and classical models of radiative properties of materials, electromagnetic wave theory for thermal radiation, radiative transfer in absorbing, emitting, and scattering media, and coherent laser radiation. Applications cover laser-material interactions, imaging, infrared instrumentation, global warming, semiconductor manufacturing, combustion, furnaces, and high temperature processing.  
G. Chen

2.59] Thermal Hydraulics in Power Technology  
(Same subject as 10.536, 22.313)  
Prereq: 2.006, 10.302, 22.312, or permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Spring)  
3-2-7 H-LEVEL Grad Credit  
See description under subject 22.313.  
M. S. Kazimi, N. E. Todreas

ENERGY AND POWER SYSTEMS

2.60] Fundamentals of Advanced Energy Conversion  
(Same subject as 3.083)  
(Subject meets with 2.62J, 3.64J, 10.392J, 22.40J)  
Prereq: 2.006, 3.044, or permission of instructor  
U (Spring)  
4-0-8  
Fundamentals of thermodynamics, chemistry, and transport applied to energy systems. Analysis of energy conversion and storage in thermal, mechanical, chemical, and electrochemical processes in power and transportation systems, with emphasis on efficiency, performance, and environmental impact. Applications to fuel reforming and alternative fuels, hydrogen, fuel cells and batteries, combustion, catalysis, combined and hybrid power cycles using fossil, nuclear and renewable resources. CO2 separation and capture. Biomass energy. Students taking the graduate version complete additional assignments.  
A. F. Ghoniem, M. Kazimi, Y. Chiang

2.61 Internal Combustion Engines  
Prereq: 2.006  
G (Spring)  
3-1-8 H-LEVEL Grad Credit  
Fundamentals of how the design and operation of internal combustion engines affect their performance, efficiency, fuel requirements, and environmental impact. Study of fluid flow, thermodynamics, combustion, heat transfer and friction phenomena, and fuel properties, relevant to engine power, efficiency, and emissions. Examination of design features and operating characteristics of different types of internal combustion engines: spark-ignition, diesel, stratified-charge, and mixed-cycle engines. Engine Laboratory project. For graduate and senior undergraduate students.  
W. K. Cheng

2.611 Marine Power and Propulsion  
(Subject meets with 2.612)  
Prereq: 2.005  
G (Fall)  
4-0-8 H-LEVEL Grad Credit

2.612 Marine Power and Propulsion  
(Subject meets with 2.611)  
Prereq: 2.005  
U (Fall)  
4-0-8  
Selection and evaluation of commercial and naval ship power and propulsion systems.
2.62J Fundamentals of Advanced Energy Conversion
(Same subject as 3.64J, 10.392J, 22.40J)
(Subject meets with 2.60J, 3.083J)
Prereq: 2.006, 3.044, or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
Fundamentals of thermodynamics, chemistry, and transport applied to energy systems. Analysis of energy conversion and storage in thermal, mechanical, chemical, and electrochemical processes in power and transportation systems, with emphasis on efficiency, performance and environmental impact. Applications to fuel reforming and alternative fuels, hydrogen, fuel cells and batteries, combustion, catalysis, combined and hybrid power cycles using fossil, nuclear and renewable resources. CO₂ separation and capture. Biomass energy.
A. F. Ghoniem, M. Kazimi, Y. Chiang

2.625J Electrochemical Energy Conversion and Storage: Fundamentals, Materials and Applications
(Same subject as 10.625J)
Prereq: 3.53, 2.005, 3.046, 10.40, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
4-0-8 H-LEVEL Grad Credit
Fundamental concepts, tools, and applications in electrochemical science and engineering. Introduces thermodynamics, kinetics and transport of electrochemical reactions. Describes how materials structure and properties affect electrochemical behavior of particular applications, for instance in lithium rechargeable batteries, electrochemical capacitors, fuel cells, photo electrochemical cells, and electrolytic cells. Discusses state-of-the-art electrochemical energy technologies for portable electronic devices, hybrid and plug-in vehicles, electrical vehicles. Theoretical and experimental exploration of electrochemical measurement techniques in cell testing, and in bulk and interfacial transport measurements (electronic and ionic resistivity and charge transfer cross the electrode-electrolyte interface).
Y. Shao-Horn

2.626 Fundamentals of Photovoltaics
(Subject meets with 2.627)
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
T. Buonassisi

2.627 Fundamentals of Photovoltaics (New)
(Subject meets with 2.626)
Prereq: Permission of instructor
U (Fall)
4-0-8
T. Buonassisi

2.63 Applications of Technology in Energy and the Environment
Engineering School-Wide Elective Subject
(Offered under: 1.149, 2.63, 5.00, 10.579, 22.813, ESD.174)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.813.
J. Deutch, R. Lester

2.64 Superconducting Magnets
Prereq: 2.51
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Focuses on one important engineering application of superconductors—generation of large-scale and intense magnetic fields. Review of electromagnetic theory; detailed treatment of magnet design and operational issues, including “usable” superconductors, field and stress analyses, magnet instabilities, ac losses and mechanical disturbances, quench and protection, experimental techniques, and cryogenics. New high-temperature superconductors for magnets—design and operational issues at high temperatures.
Y. Iwasa

2.65j Sustainable Energy
(Same subject as 1.818J, 10.391J, 11.371J, 22.811J, ESD.166J)
(Subject meets with 2.650J, 10.291J, 22.081J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 22.811J.
M. W. Golay, J. P. Freidberg

2.650j Introduction to Sustainable Energy (New)
(Same subject as 10.291J, 22.081J)
(Subject meets with 1.818J, 2.65J, 10.391J, 11.371J, 22.811J, ESD.166J)
Prereq: Permission of instructor
U (Fall)
3-1-8
See description under subject 22.081J.
M. W. Golay, J. P. Freidberg

2.66j Fundamentals of Energy in Buildings
(Same subject as 1.044J, 4.42J)
Prereq: Physics I (GIR), Calculus II (GIR)
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-2-7 REST
See description under subject 4.42J.
L. R. Glicksman

2.661j Architectural Thermal and Fluid Dynamics
(Same subject as 4.423J)
Prereq: 2.005, 4.42, or 2.25
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-2-7 H-LEVEL Grad Credit
See description under subject 4.423J.
L. Glicksman, L. K. Norford
2.671 Analysis and Design of Heating, Ventilating, and Air Conditioning Systems
(Same subject as 4.427J)
Prereq: 2.006 or 4.42
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 4.427J.
L. K. Norford, L. Glicksman

EXPERIMENTAL ENGINEERING

2.670 Mechanical Engineering Tools
Prereq: None
U (IAP)
0-3-0 [P/D/F]
Introduces the fundamentals of machine tool and computer tool use. Students work with a variety of machine tools including the bandsaw, milling machine, and lathe. Instruction given on the use of software packages. Assignments are project-oriented relating to mechanical engineering topics. It is recommended that students take this subject in the first IAP after declaring the major in Mechanical Engineering.
D. Frey, R. Fenner, B. J. Hughey

2.671 Measurement and Instrumentation
Prereq: 2.001; 2.003; Physics II (GIR)
U (Fall, Spring)
3-3-6 Institute LAB
Experimental techniques for observation and measurement of physical variables such as force, strain, temperature, flowrate, and acceleration. Emphasizes principles of transduction, measurement circuitry, MEMS sensors, Fourier transforms, linear and nonlinear function fitting, uncertainty analysis, probability density functions and statistics, system identification, electrical impedance analysis and transfer functions, computer-aided experimentation, and technical reporting. Typical laboratory experiments involve oscilloscopes, electronic circuits including operational amplifiers, thermocouples, strain gauges, digital recorders, lasers, etc. Basic material and lab objectives are developed in lectures. Instruction and practice in oral and written communication provided. Enrollment limited.
I. W. Hunter, J. J. Leonard

2.672 Project Laboratory
Prereq: 2.001, 2.003, 2.006, 2.671
U (Fall, Spring)
0-3-3 1/2 Institute LAB

Major emphasis on interplay between analytical and experimental methods in solution of research and development problems. Communication (written and oral) of results is also a strong component of the course. Groups of two or three students work together on three projects during the term. Enrollment limited.
W. Cheng, D. P. Hart

2.673J Instrumentation and Measurement for Biological Systems
(Same subject as 6.122J, 20.309J, MAS.402J)
(Subject meets with 20.409)
Prereq: Biology (GIR), Physics II (GIR), 6.00,
18.03; 2.001, 2.301, or 6.02; or permission of instructor; Coreq: 20.330
U (Fall, Spring)
3-6-3
See description under subject 20.309J.
Fall: S. Manalis, P. T. So, S. Wasserman
Spring: E. Boyden, S. Wasserman, M. F. Yanik

2.674 Micro/Nano Engineering Laboratory
(Subject meets with 2.675)
Prereq: 2.001, 2.003, 2.005; 2.671 or permission of instructor
U (Spring)
1-3-2

2.675 Micro/Nano Engineering Laboratory
(Subject meets with 2.674)
Prereq: 2.25; 2.372 or permission of instructor
G (Spring)
1-3-8 H-LEVEL Grad Credit

Concepts, ideas, and enabling tools of nanotechnology taught through modules and imaging tools, which include microfluidics, microthermal systems, MEMS, nanomaterials, SEM, TEM, and AFM. Provides practical knowledge and experience via building, observing and manipulating micro- and nanoscale structures. Teaches students how to apply engineering knowledge to practical fluid, thermal, and dynamic systems at small scales. Students taking the graduate version complete additional assignments. Enrollment limited. Subject 2.674 gives enrollment preference to Course 2 undergraduates.
S. G. Kim, C. Livermore, G. Chen, E. Wang, R. Karnik

OCEANOGRAPHIC ENGINEERING AND ACOUSTICS

2.681 Environmental Ocean Acoustics
Prereq: 2.066, 18.075 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Fundamentals of underwater sound, and its application to mapping and surveillance in an ocean environment. Wave equations for fluid and elastic media. Reflection and transmission of sound at plane interfaces. Wave theory representation of acoustic source radiation and propagation in shallow and deep ocean waveguides. Interaction of underwater sound with elastic waves in the seabed and an Arctic ice cover, including effects of porosity and anisotropy. Numerical modeling of the propagation of underwater sound, including spectral methods, normal mode theory, and the parabolic equation method, for laterally homogeneous and inhomogeneous environments. Doppler effects. Effects of oceanographic variability and fluctuation - spatial and temporal coherence. Generation and propagation of ocean ambient noise. Modeling and simulation of signals and noise in traditional sonar systems, as well as modern, distributed, autonomous acoustic surveillance systems.
H. Schmidt

2.682 Acoustical Oceanography
Prereq: 2.681
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Provides brief overview of what important current research topics are in oceanography (physical, geological, and biological) and how acoustics can be used as a tool to address them. Three typical examples are climate, bottom geology, and marine mammal behavior. Addresses the acoustic inverse problem, reviewing inverse methods (linear and nonlinear) and the combination of acoustical methods with other measurements as an integrated system. Concentrates on specific case studies, taken from current research journals.
J. F. Lynch, Woods Hole Staff
2.683 Marine Bioacoustics and Geoacoustics  
Prereq: 2.681  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
Both active and passive acoustic methods of measuring marine organisms, the seafloor, and their interactions are reviewed. Acoustic methods of detecting, observing, and quantifying marine biological organisms are described, as are acoustic methods of measuring geological properties of the seafloor, including depth, and surficial and volumetric composition. Interactions are also described, including effects of biological scatterers on geological measurements, and effects of seafloor scattering on measurements of biological scatterers on, in, or immediately above the seafloor. Methods of determining small-scale material properties of organisms and the seafloor are outlined. Operational methods are emphasized, and corresponding measurement theory is described. Case studies are used in illustration. Principles of acoustic-system calibration are elaborated.  
K. G. Foote, Woods Hole Staff

2.684 Wave Scattering by Rough Surfaces and Inhomogeneous Media  
Prereq: 2.066 or permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
An advanced-level subject designed to give students a working knowledge of current techniques in this area. Material is presented principally in the context of ocean acoustics, but can be used in other acoustic and electromagnetic applications. Includes fundamentals of wave propagation through, and/or scattering by, random media, extended coherent structures, rough surfaces, and discrete scatterers.  
T. K. Stanton, A. C. Lavery, Woods Hole Staff

2.685 Numerical Methods in Wave Scattering  
Prereq: 2.066, 18.06  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
Fundamental equations for acoustic and electromagnetic waves are derived from first principles. Boundary, or interface, conditions introduced. The development of numerical methods to solve wave equations in interior or exterior domains, using boundary-element and finite-element techniques, is emphasized. Spectral techniques are also developed. A number of technical computational issues are addressed, including discretization of geometry, order of approximation, efficiency, and analysis of numerical schemes. Validation is an essential exercise. Validation examples are drawn from analytical solutions for separable shapes. Applications of numerical methods are presented for acoustic scattering by marine organisms of complex shape and structure, and optical scattering by dielectric bodies. Assignments entail code development.  
G. R. Feijoo, K. G. Foote, Woods Hole Staff

2.686J Sonar, Radar, and Seismic Signal Processing  
(Same subject as 6.455J, 12.518J)  
Prereq: 2.004 or 6.003; 6.041; 18.075 or 18.085  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
Signal processing used in sonar, radar, and geophysical data analysis. Active sonar and radar systems: matched filters and ambiguity functions, signal design of range/doppler resolution, second moment characterizations of random processes with correlation functions and power density spectra, deconvolution, spectral estimation by Fourier techniques and adaptive methods, beam forming.  
N. C. Makris, J. C. Preisig, Woods Hole Staff

2.687 Time Series Analysis and System Identification  
Prereq: 6.003, 6.431, 18.06  
Acad Year 2009–2010: G (Fall)  
Acad Year 2010–2011: Not offered  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
Matched filtering, power spectral estimation and adaptive signal processing and system identification algorithms are introduced. Algorithm development is framed as an optimization problem, and methods of finding both optimal and approximate solutions are described. Introduction to time-varying systems, first and second moment characterizations of stochastic processes, and state-space models. Algorithm derivation, performance analysis and robustness to modeling errors are covered for matched filter and power spectral estimation algorithms, stochastic gradient algorithms (LMS and its variants), Least Squares algorithms (RLS, order-recursive approaches), and the discrete-time Kalman filter and its derivatives. Includes laboratory exercises involving working with experimental data from a variety of fields. Term paper/project is required.  
J. C. Preisig, Woods Hole Staff

2.688 Principles of Oceanographic Instrument Systems—Sensors and Measurements  
Prereq: 18.075, 2.671  
G (Fall)  
3-3-6 H-LEVEL Grad Credit  
Introduces theoretical and practical principles of design of oceanographic sensor systems. Transmitting parameters for acoustic, current, temperature, pressure, electric, magnetic, gravity, salinity, velocity, heat flow, and optical devices. Limitations on these devices imposed by ocean environment. Signal conditioning and recording; noise, sensitivity, and sampling limitations; standards. Principles of state-of-the-art systems being used in physical oceanography, geophysics, submersibles, acoustics discussed in lectures by experts in these areas. Day cruises in local waters during which the students will prepare, deploy and analyze observations from standard oceanographic instruments constitute the lab work for this subject.  
M. A. Grosenbaugh, H. Singh, G. Terray, Woods Hole Staff

2.689J Special Projects in Oceanographic Engineering  
(Same subject as 1.699J)  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit  
Special problems in oceanographic engineering, carried out under supervision of members of the staff of the Woods Hole Oceanographic Institution. Given at Woods Hole Oceanographic Institution.  
T. K. Stanton, Woods Hole Staff

NAVAL ARCHITECTURE

2.701 Principles of Naval Architecture  
Prereq: 2.002 or 2.012  
G (Fall)  
3-0-9  
Introduction to principles of naval architecture, ship geometry, hydrostatics, calculation and drawing of curves of form, intact and damage stability, hull structure strength calculations and ship resistance. Projects include analysis of ship lines drawings and ship model testing.  
M. S. Welsh, T. R. Gooding
2.702 Computer-Aided Design and Systems Engineering of Naval Ships
Prereq: 2.701
G (Fall)
Units arranged [P/D/F] H-LEVEL Grad Credit
Introduction to principles of systems engineering, computer-aided naval ship design and analysis tools. Emphasizes utilization of computer-aided tools and application of design principles. Naval ship design and acquisition processes; requirements setting, design philosophy and constraints, selection criteria, design optimization, variant analysis, design trade-offs, analysis of ship design trends, and cost analysis.
M. S. Welsh, T. R. Gooding

2.703 Principles of Naval Ship Design
Prereq: 2.082, 2.20, 2.611, 2.702
G (Fall)
3-1-8 H-LEVEL Grad Credit
Design of surface ship platforms for naval applications; introduction to formal design decision making methods; mathematical and computer models of ship design process; engineering and economic principles governing selection of dimensions and coefficients; influence of hull form and dimensions on seakeeping and ship motions in irregular seas using wave energy spectra and response amplitude operator methods; internal subdivisions for efficient arrangement and maximum survivability; damage stability. Introduction to advanced hullforms. Design projects in application of principles.
T. R. Gooding, M. S. Welsh

2.704 Projects in Naval Ship Conversion Design
Prereq: 2.703
G (Spring)
1-0-5 H-LEVEL Grad Credit
Focus on conversion design of a naval ship. A new mission requirement is defined, requiring significant modification to an existing ship. Requirements setting, design plan formulation, design philosophy and formal decision making methods are used. Technical aspects demonstrate feasibility and desirability. Formal written and verbal reports. Team projects.
M. S. Welsh, T. R. Gooding

2.705 Projects in New Concept Naval Ship Design
Prereq: 2.704
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Focus on preliminary design of a new naval ship, fulfilling a given set of mission requirements. Design plan formulation, system level trade-off studies, emphasizes achieving a balanced design and total system integration. Formal written and oral reports. Team projects extend over three terms.
M. S. Welsh, T. R. Gooding

2.706 Sailing Vessel Design
Prereq: 2.701 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring) 3-5-4 H-LEVEL Grad Credit
Naval Architecture review, hydrostatics, hydrodynamics and sail aerodynamics unique to sailing vessels, sail and hull heeling moment constraints, parameters of form found for “good” boats. Hull drag decomposition, structural design based on fundamentals and on “rules” of classification organizations. Individual design project including: hull shape, appendages for side force and control, rig design, dimensions of spars and rigging, and detailed structural design of hull and appendages. CAD and performance prediction are used as design aids. Structural component dimensions, design loads, and design deflections are organized with a computer spreadsheet by each student. Enrollment limited to 25.
Staff

2.707 Submarine Structural Acoustics
Prereq: 2.066
Acad Year 2009–2010: G (Spring; first half of term)
Acad Year 2010–2011: Not offered
2-0-4 H-LEVEL Grad Credit
Introduction to the acoustic interaction of submerged structures with the surrounding fluid. Fluid and elastic wave equations. Elastic waves in plates. Radiation and scattering from planar structures as well as curved structures such as spheres and cylinders. Acoustic imaging of structural vibrations. Students can take 2.085 in the second half of term.
H. Schmidt

2.710 Optics
Prereq: Physics II (GIR); 18.03; 2.004 or permission of instructor
U (Spring)
3-0-9
Introduction to optical science with elementary engineering applications. Geometrical optics: ray-tracing, aberrations, lens design, apertures and stops, radiometry and photometry. Wave optics: basic electrodynamics, polarization, interference, wave-guiding, Fresnel and Fraunhofer diffraction, image formation, resolution, space-bandwidth product. Emphasis on analytical and numerical tools used in optical design. Graduate students are required to complete additional assignments with stronger analytical content, and an advanced design project.
G. Barbastathis, P. T. So

2.715J Optical Microscopy and Spectroscopy for Biology and Medicine
(Subject meets with 20.487J)
Prereq: Permission of instructor
G (Fall)
3-0-9
Introduction to optical microscopy and its applications in biology and medicine. The course starts from an overview of basic optical principles allowing an understanding of microscopic image formation and common contrast modalities such as dark field, phase, and DIC. Advanced microscopy imaging techniques such as total internal reflection, confocal, and multiphoton will also be discussed. Quantitative analysis of biochemical microenvironment using spectroscopic techniques based on fluorescence, second harmonic, Raman signals will be covered. We will also provide an overview of key image processing techniques for microscopic data.
P. T. So, C. Sheppard

2.717 Optical Engineering
Prereq: 2.710 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall) 3-0-9 H-LEVEL Grad Credit
Theory and practice of optical methods in engineering and system design. Emphasis on...
diffraction, statistical optics, holography, and imaging. Provides engineering methodology skills necessary to incorporate optical components in systems serving diverse areas such as precision engineering and metrology, bio-imaging, and computing (sensors, data storage, communication in multi-processor systems). Experimental demonstrations and a design project are included.

P. T. So, G. Barbastathis

**DE**

**S**

2.72 Elements of Mechanical Design
Prereq: 2.005, 2.007; Coreq: 2.671
U (Spring)
3-3-6

Advanced subject on modeling, design, integration and best practices for use of machine elements such as bearings, springs, gears, cams and mechanisms. Modeling and analysis of these elements is based upon extensive application of physics, mathematics and core mechanical engineering principles (solid mechanics, fluid mechanics, manufacturing, estimation, and modeling). These principles are reinforced via laboratory experiences wherein students conduct experiments and disassemble machines and a substantial design project wherein students model, design, fabricate and characterize a mechanical system that is relevant to a real world application. Students master the materials via problems sets that are directly related to, and coordinated with, the deliverables of their project. Student assessment is based upon mastery of the subject materials and the student’s ability to synthesize, model and fabricate a mechanical device subject to engineering constraints (e.g. cost and time/schedule). Enrollment limited.

M. L. Culpepper

2.722) D-Lab: Design
(Same subject as SP.722)
Prereq: 2.670 or permission of the instructor
U (Spring)
3-0-9

See description under subject SP.722).

A. B. Smith, J. K. Vandiver

2.737 Mechatronics
Prereq: 6.071 or 6.002; 2.14, 6.302, or 16.30
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-5-4 H-LEVEL Grad Credit

Introduction to designing mechatronic systems, which require integration of the mechanical and electrical engineering disciplines within a unified framework. Significant laboratory-based design experiences form subject’s core. Final project. Topics include: low-level interfacing of software with hardware; use of high-level graphical programming tools to implement real-time computation tasks; digital logic; analog interfacing and power amplifiers; measurement and sensing; electromagnetic and optical transducers; control of mechatronic systems. Enrollment limited to 20.

D. L. Trumper, K. Youcef-Toumi

**2.739J** Product Design and Development
(Same subject as 15.783, ESD.321)
Prereq: 2.009, 15.760, 15.761, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 15.783).

S. Eppinger, W. P. Seering

2.744J Product Design
(Same subject as ESD.64J)
Prereq: 2.009
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-1-8 H-LEVEL Grad Credit

Project-centered subject addressing transformation of ideas into successful products which are properly matched to the user and the market. Students are asked to take a more complete view of a new product and to gain experience with designs judged on their aesthetics, ease of use, and sensitivities to the realities of the marketplace.

Lectures on modern design process, industrial design, visual communication, form-giving, mass production, marketing, and environmentally conscious design.

D. R. Wallace

2.745 Invention
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-2-7 H-LEVEL Grad Credit

Exposes students to the culture and methodology of the inventor. Examples of past invention and their impact on technology and society in their historical context. Examines the interplay between analysis and synthesis in the inventive process. Formal methods of promoting synthesis includes classic brainstorming, morphological analysis, and TRIZ theory. Through case studies, examine how feasibility study and proof of concept can be accomplished as well as the cyclical progression of a project through stages of synthesis, analysis and test. Elements of patent law. Majority of student effort is spent inventing.

Laboratory time focused on proof of concept.

E. M. Sachs

2.75 Precision Machine Design
(Subject meets with 2.750)
Prereq: 2.72 or permission of instructor
G (Fall)
4-3-5 H-LEVEL Grad Credit

2.750 Precision Machine Design
(Subject meets with 2.75)
Prereq: 2.72 or permission of instructor
U (Fall)
4-3-5

Intensive coverage of precision engineering theory, heuristics, and applications pertaining to the design of systems ranging from consumer products to machine tools and instruments. Topics covered include: economics, project management and design philosophy; principles of accuracy, repeatability, and resolution; error budgeting; sensors and sensor mounting; systems design; bearings; actuators and transmissions; and system integration driven by functional requirements and operating physics.

Emphasis on developing creative designs that are optimized by analytical techniques. Problem sets and test during first six weeks. Major team-based design project focus during last six weeks. Students taking the graduate version complete additional assignments. Subject 2.750 provides instruction and practice in written and oral communication.

A. H. Slocum, M. L. Culpepper

2.752 Development of Mechanical Products
(Subject meets with 2.753)
Prereq: 2.750, 2.009, or permission of instructor
U (Spring)
3-0-9

Focuses on evolving a product from proof-of-concept to beta prototype: Includes team building, project planning, budgeting, resource planning; models for scaling, tolerancing and reliability, patents, business planning. Students/teams start with a proof-of-concept product they bring to class or select from projects provided by instructor. In lieu of taking 12 units of 2.ThU, Course 2 majors taking 2.752 may write a bachelor's thesis that documents their contributions to the product developed in the team project. Students taking the graduate version complete additional assignments.

A. Slocum
BIOENGINEERING

2.771J Biomedical Information Technology
(Same subject as 20.453J, HST.958J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.453J.
C. F. Dewey, Jr., S. Bhownik (NTU, Singapore)

2.772J Thermodynamics of Biomolecular Systems
(Same subject as 20.110J)
Prereq: Calculus II (GIR), Chemistry (GIR)
U (Fall)
5-0-7 REST
See description under subject 20.110J.
L. G. Griffith, K. Hamad-Schifferli

2.782J Design of Medical Devices and Implants
(Same subject as 3.961J, 20.451J, HST.524J)
Prereq: 2.79J or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
I. V. Yannas, M. Spector

2.785J Cell-Matrix Mechanics
(Same subject as 3.97J, 20.411J, HST.523J)
Prereq: 2.005 or 5.60; Biology (GIR); Chemistry (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit
Mechanical forces play a decisive role during development of tissues and organs, during remodeling following injury as well as in normal function. A stress field influences cell function primarily through deformation of the extracellular matrix to which cells are attached. Deformed cells express different biosynthetic activity relative to undeformed cells. The unit cell process paradigm combined with topics in connective tissue mechanics form the basis for discussions of several topics from cell biology, physiology, and medicine.
I. V. Yannas, M. Spector

2.791J Cellular Biophysics
(Same subject as 6.021J, 20.370J)
(Same subject meets with 2.794J, 6.521J, 20.470J, HST.541J)
Prereq: Physics II (GIR); 18.03; 2.005, 6.002, 6.003, 6.071, 10.301, or permission of instructor
U (Fall)
5-2-5
See description under subject 6.021J.
D. M. Freeman, J. Han, J. Voldman

2.792J Quantitative Systems Physiology
(Same subject as 6.022J, 20.371J, HST.542J)
(Same subject meets with 2.796J, 6.522J, 20.471J)
Prereq: Physics II (GIR); 18.03, or permission of instructor
U (Spring)
4-2-6
See description under subject 6.022J.
R. G. Mark, C. M. Stultz

2.793J Fields, Forces and Flows in Biological Systems
(Same subject as 6.023J, 20.330J)
Prereq: 2.005, 6.021, 20.320 or permission of instructor
U (Spring)
4-0-8
See description under subject 20.330J.
J. Han, L. Griffith

2.794J Cellular Biophysics
(Same subject as 6.521J, 20.470J, HST.541J)
(Same subject meets with 2.791J, 6.021J, 20.370J)
Prereq: Physics II (GIR); 18.03; 2.005, 6.002, 6.003, 6.071, 10.301, 20.110, or permission of instructor
G (Fall)
5-2-5 H-LEVEL Grad Credit
See description under subject 6.521J.
D. M. Freeman, J. Han
2.795J Fields, Forces, and Flows in Biological Systems
(Same subject as 6.561J, 10.539J, 20.430J, HST.544J)
Prereq: 6.013, 2.005, 10.302, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.430J.
A. J. Grodzinsky, D. Lauffenburger

2.796J Quantitative Physiology: Organ Transport Systems
(Same subject as 6.522J, 20.471J)
Subject meets with 2.792J, 6.022J, 20.371J, HST.542J)
Prereq: 2.006 or 6.013; 6.021J
G (Spring)
4-2-6 H-LEVEL Grad Credit
See description under subject 6.522J.
R. G. Mark, C. M. Stultz

2.797J Molecular, Cellular, and Tissue Biomechanics
(Same subject as 3.053J, 6.024J, 20.310J)
Prereq: 2.370 or 2.772J; 18.03 or 3.016; Biology (GIR)
U (Spring)
4-0-8
Develops and applies scaling laws and the methods of continuum mechanics to biomechanical phenomena over a range of length scales. Topics include structure of tissues and the molecular basis for macroscopic properties; chemical and electrical effects on mechanical behavior; cell mechanics, motility and adhesion; biomembranes; biomolecular mechanics and molecular motors. Experimental methods for probing structures at the tissue, cellular, and molecular levels.
R. D. Kamm

2.798J Molecular, Cellular, and Tissue Biomechanics
(Same subject as 3.971J, 6.524J, 10.537J, 20.410J)
Prereq: Biology (GIR); 2.002, 2.006, 6.013, 10.301, or 10.302
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.410J.
A. J. Grodzinsky, M. Bathe

MANUFACTURING

2.800 Tribology
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Fundamental mechanisms of friction and wear. Design of tribological systems. Topics include geometric, chemical, and physical characterization of surfaces; friction and wear mechanisms for metals, polymers, and ceramics, including abrasive wear, delamination theory, solution wear, erosive wear, wear of polymers and composites; and boundary lubrication and solid-film lubrication; relationship between nano-tribology and macro-tribology, rolling contacts, tribological problems in magnetic recording and electrical contacts, and monitoring and diagnosis of friction and wear. Case studies.
Staff

2.810 Manufacturing Processes and Systems
Prereq: 2.001, 2.006, 2.008
G (Fall)
3-3-6 H-LEVEL Grad Credit
Introduction to manufacturing processes and manufacturing systems including assembly, machining, injection molding, casting, thermoforming, and more. Emphasis on the physics and randomness and how they influence quality, rate, cost, and flexibility. Attention to the relationship between the process and the system, and the process and part design. Project (in small groups) requires fabrication (and some design) of a product using several different processes (as listed above).
T. G. Gutowski

2.813 Environmentally Benign Design and Manufacturing
(Subject meets with 2.83)
Prereq: 2.008 or permission of instructor
U (Spring)
3-0-9
Introduction to the major dilemma that faces manufacturing and society for the 21st century: how to support economic development while protecting the environment. Subject addresses industrial ecology, materials flows, life cycle analysis, thermodynamic analysis and exergy accounting, manufacturing process performance, product design analysis, design for the environment, recycling and ecological economics. Class follows a mixed format with lectures and group discussions of journal articles and selected literature, often with opposing views. Graduate students complete term-long project with report required for graduate credit.
T. G. Gutowski

2.830J Control of Manufacturing Processes
(Same subject as 6.780J, ESD.63J)
Prereq: 2.008, 2.810, 6.041, 6.152J, or 15.064J
G (Spring)
3-0-9 H-LEVEL Grad Credit
Statistical modeling and control in manufacturing processes. Use of experimental design and response surface modeling to understand manufacturing process physics. Defect and parametric yield modeling and optimization. Forms of process control, including statistical process control, run by run and adaptive control, and real-time feedback control. Application contexts include semiconductor manufacturing, conventional metal and polymer processing, and emerging micro-nano manufacturing processes.
D. E. Hardt, D. S. Boning

2.851J System Optimization and Analysis for Manufacturing
(Same subject as 15.066J, ESD.750J)
Prereq: Calculus II (GIR)
G (Summer)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.066J.
S. C. Graves, J. P. Clark, J. Gallien

2.852J Manufacturing Systems Analysis
Prereq: 6.041 or permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Models of manufacturing systems, including transfer lines and flexible manufacturing systems. Calculation of performance measures,
including throughput, in-process inventory, and meeting production commitments. Real-time control of scheduling. Effects of machine failure, set-ups, and other disruptions on system performance.

S. B. Gershwin

2.853 Introduction to Manufacturing Systems
(Subject meets with 2.854)
Prereq: 2.008
U (Fall)
3-0-9

2.854 Introduction to Manufacturing Systems
(Subject meets with 2.853)
Prereq: Undergraduate mathematics
G (Fall)
3-0-9 H-LEVEL Grad Credit

Provides ways to analyze manufacturing systems in terms of material flow and storage, information flow, capacities, and times and durations of events. Fundamental topics include probability, inventory and queuing models, forecasting, optimization, process analysis, and linear and dynamic systems. Factory planning and scheduling topics include flow planning, bottleneck characterization, buffer and batch-size tactics, seasonal planning, and dynamic behavior of production systems. Graduate students are required to complete additional assignments.

S. B. Gershwin

2.875j Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development
(Same subject as ESD.875j)
Prereq: 2.008
G (Fall)
3-0-9 H-LEVEL Grad Credit

Introduces mechanical and economic models of assemblies and assembly automation on two levels. Assembly in the small comprises basic engineering models of rigid and compliant part mating and explains the operation of the Remote Center Compliance. Assembly in the large takes a system view of assembly, including the notion of product architecture, feature-based design and computer models of assemblies, analysis of mechanical constraint, assembly sequence analysis, tolerances, system-level design for assembly and JIT methods, and economics of assembly automation. Case studies and current research included. Class exercises and homework include analyses of real assemblies, the mechanics of part mating, and a semester long project.

D. E. Whitney

2.882 System Design and Analysis
Prereq: 2.004, 2.006
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Fundamentals of axiomatic design and complexity theory. Application of the independence axiom and the information axiom to design of products (e.g., hardware and software), complicated systems, organizations, and manufacturing processes. Coupled design, decoupled design and uncoupled design. Robust design and reliable design. Reduction of complexity of engineered systems. Real complexity, imaginary complexity, combinatorial complexity, and periodic complexity. Functional periodicity. Stability criteria for engineered systems and natural systems. Case studies.

S. G. Kim

2.888 Professional Seminar in Global Manufacturing Innovation and Entrepreneurship
Prereq: None
G (Spring)
2-0-1

Covers a broad range of topics in modern manufacturing, from models and structures for 21st-century operations, to case studies in leadership from the shop floor to the executive office. Also includes global perspectives from Asia, Europe and North America, with guest speakers from all three regions. Opportunities for new ventures in manufacturing are explored. Intended primarily for MEng in Manufacturing students.

D. E. Hardt, S. B. Gershwin

2.890j Proseminar in Manufacturing
(Same subject as 3.880, 10.792j, 15.792j, 16.985j)
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

See description under subject 15.792j.

D. B. Rosenfield

ENGINEERING MANAGEMENT

2.96 Management in Engineering
Engineering School-Wide Elective Subject
(Offered under: 2.96, 6.930, 10.806, 16.653)
Prereq: None
U (Fall)
3-1-8

Introduction and overview of engineering management. Financial principles, management of innovation, technical strategy and best management practices. Case study method of instruction emphasizes participation in class discussion. Focus is on the development of individual skills and management tools.

H. S. Marcus

2.961 Management in Engineering
Prereq: None
G (Fall)
3-1-8

Introduction and overview of engineering management. Financial principles, management of innovation, technical strategy and best management practices. Case study method of instruction emphasizes participation in class discussion. Focus is on the development of individual skills and management tools.

J. H. Chun

2.963 Engineering Risk-Benefit Analysis
Engineering School-Wide Elective Subject
(Offered under: 1.155, 2.963, 3.577, 6.938, 10.816, 16.862, 22.82, ESD.72)
Prereq: Calculus II (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject ESD.72.

G. E. Apostolakis

2.965j International Supply Chain Management
(Same subject as 1.265j, 15.765j, ESD.265j)
Prereq: 1.260j, 1.261j, 1.262j, 15.760, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit

An overview of globalization and the international environment: the international marketing, international finance and supply chain interface; global strategy for logistics and supply chain management; global supply chain models; role of government intervention and regulations; the role of international air and ocean carriers. Emphasis on both strategy formulation and implementation.

Staff
SPECIAL STUDIES

2.97, 2.971–2.974 Independent Activities
Prereq: None
U (IAP)
Units arranged
Can be repeated for credit
For undergraduates desiring to carry on independent or group studies during the January Independent Activities Period. Each student will carry on a program of his or her own choosing, either as an independent worker, or as a member of a team or class. Special lectures, seminars, and laboratory projects arranged when appropriate. Programs arranged on an individual basis in consultation with the instructor. 2.972–2.974 are graded P/D/F.
Consult J. H. Lienhard

2.979 Undergraduate Teaching
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
For students participating in departmentally approved undergraduate teaching programs. Students assist faculty in the design and execution of the curriculum and actively participate in the instruction and monitoring of the class participants. Students prepare subject materials, lead discussion groups, and review progress. Credit is arranged on a subject-by-subject basis and is reviewed by the department.
J. H. Lienhard

SPECIAL AND ADVANCED TOPICS IN MECHANICAL ENGINEERING

Check with our Department graduate office prior to the beginning of each term for other proposed listings.

2.993–2.995 Special Topics in Mechanical Engineering
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Designed for undergraduates wanting to continue substantial projects of own choice, under faculty supervision, in mechanical engineering. Work may be of experimental, theoretical, or design nature. Projects may be arranged individually in most fields of department interest, i.e., in mechanics, design and manufacturing, controls and robotics, thermal science and energy engineering, bioengineering, ocean engineering and nanotechnology.
Consult J. H. Lienhard

2.996–2.998 Advanced Topics in Mechanical Engineering
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit only for completely different subject matter
Assigned reading and special problems or research in special areas, either theoretical or experimental, or design. Arranged on individual basis with instructor in the following areas: mechanics and materials, thermal and fluid sciences, systems and design, biomedical engineering, and ocean engineering.
Consult D. Hardt

THESIS, RESEARCH AND PRACTICE

2.999 Engineer's Degree Thesis Proposal Preparation
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
For students who must do additional work to convert an SM thesis to an ME thesis, or for students who write an ME thesis after having received an SM degree.
D. Hardt, M. S. Triantafyllou

2.EPE UPOP Summer Practice Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 10.EPE, 16.EPE, 22.EPE)
Prereq: None
U (Fall, Spring, Summer)
0-1-0 [P/D/F]
Can be repeated for credit
Immerses engineering sophomores in the world of professional engineering experience by providing guided instruction in all aspects of the job acquisition process. Students complete a 10–12 week internship assignment during the summer, which includes maintaining a structured journal of observations and experiences, meeting with UPOP staff members, writing essays, and completing a self-evaluation. May be repeated twice for credit; spring term can be taken only in conjunction with fall term.
S. Luperfoy

2.EPR UPOP Reflective Learning Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPR, 2.EPR, 3.EPR, 6.EPR, 10.EPR, 16.EPR, 22.EPR)
Prereq: 2.EPE or permission of instructor
U (Fall)
0-0-3 [P/D/F]
Reflective learning experiences for engineering juniors that serve as the culmination of their sophomore year in the UPOP program. Students review their internship experiences through written and oral presentations and receive small-group and individualized coaching to reinforce the cognitive link between all aspects of the UPOP experience and their disciplinary field of study.
S. Luperfoy

2.EPW UPOP IAP Workshop
Engineering School-Wide Elective Subject
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW)
Prereq: None
U (IAP)
3-0-0 [P/D/F]
Introduction to professional development skills for engineering practice. Experiential learning modules prepare sophomores for success in summer internship and beyond. Faculty and senior engineering professionals recruited from industry guide teams through learning activities, which include creative simulations, team competitions, oral presentations, and group problem-solving. Enrollment limited.
S. Luperfoy

2.TGi Graduate Thesis
Prereq: Permission of advisor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research leading to the writing of an SM, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member.
Consult D. Hardt

2.TH U Undergraduate Thesis
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Individual self-motivated study, research, or design project under faculty supervision. Departmental program requirement: minimum of 6 units. Instruction and practice in written communication provided.
Consult J. H. Lienhard

s u b j e c t s 2 . 8 5 3 t o 2 . T h U
Bachelor of Science in Mechanical Engineering/Course 2

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 2.001 and 18.03 in the Departmental Program]</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 2.671 in the Departmental Program]</td>
<td></td>
<td>2</td>
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<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td></td>
<td>17</td>
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<tr>
<th>Communication Requirement</th>
<th>Units</th>
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<tbody>
<tr>
<td>The program includes a Communication Requirement of 4 subjects:</td>
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<tr>
<td>2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and</td>
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<tr>
<td>2 subjects designated as Communication Intensive in the Major (CI-M) [satisfied by 2.009 and 2.671 in the Departmental Program].</td>
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<tr>
<th>PLUS Departmental Program</th>
<th>Units</th>
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<tbody>
<tr>
<td>Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).</td>
<td></td>
</tr>
<tr>
<td>Required Departmental Core Subjects</td>
<td>159</td>
</tr>
<tr>
<td>2.001 Mechanics and Materials I, 12; REST; Physics I (GIR), Calculus II (GIR), 18.03</td>
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<tr>
<td>2.002 Mechanics and Materials II, 12; 2.001, Chemistry (GIR)</td>
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<tr>
<td>2.003 Dynamics and Control I, 12; REST; Physics I (GIR), 18.03</td>
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<tr>
<td>2.004 Dynamics and Control II, 12; 2.003J, Physics II (GIR)</td>
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<tr>
<td>2.005 Thermal-Fluids Engineering I, 12; REST; Physics II (GIR), Calculus II (GIR), 18.03</td>
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<tr>
<td>2.006 Thermal-Fluids Engineering II, 12; 2.005, 18.03</td>
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<tr>
<td>2.008 Design and Manufacturing II, 12, 1/2 LAB; 2.001; 2.005; 2.007 or 2.037J</td>
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<tr>
<td>2.009 The Product Engineering Process, 12, CI-M; 2.001, 2.003J, 2.005; 2.670 or 2.008B; senior standing or permission of instructor</td>
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<tr>
<td>2.086 Numerical Computation for Mechanical Engineers, 12; 2.001, 2.003J, 2.005</td>
<td></td>
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<tr>
<td>2.670 Mechanical Engineering Tools, 3</td>
<td></td>
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<tr>
<td>2.671 Measurement and Instrumentation, 12, LAB, CI-M; 2.001, 2.003J, Physics II (GIR)</td>
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<tr>
<td>2.672 Project Laboratory, 6, 1/2 LAB; 2.001, 2.003J, 2.005, 2.671</td>
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<tr>
<td>18.03 Differential Equations, 12; REST; Calculus II (GIR)</td>
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<tr>
<td>2.003J Design of Ocean Systems, 12, 1/2 LAB; 2.001; 2.003J; 2.005 or 2.016; 2.671</td>
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<tr>
<td>or 2.017J Design of Electromechanical Robotic Systems, 12, 1/2 LAB; 2.003J; 2.005 or 2.016; 2.671</td>
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| Restricted Elective Subjects                                                                           | 24     |
| Students are required to take two of the following elective subjects (substitutions by petition to the ME Undergraduate Office): |       |
| 2.016 Hydrodynamics, 12; Physics II (GIR), 18.03                                                      |       |
| 2.017J Design of Electromechanical Robotic Systems, 12, 1/2 LAB; 2.003J; 2.005 or 2.016; 2.671      |       |
| 2.019 Design of Ocean Systems, 12, CI-M; 2.001; 2.003J; 2.005 or 2.016; senior standing or permission of instructor |       |
| 2.092 Computer Methods in Dynamics, 12; 2.001, 2.003J                                              |       |
| 2.12 Introduction to Robotics, 12; 2.004                                                          |       |
| 2.14 Analysis and Design of Feedback Control Systems, 12; 2.004                                    |       |
| 2.370 Molecular Mechanics, 12; 2.001; Chemistry (GIR)                                               |       |
| 2.51 Intermediate Heat and Mass Transfer, 12; 2.006*                                               |       |
| 2.601 Fundamentals of Advanced Energy Conversion, 12; 2.006*                                      |       |
| 2.71 Optics, 12; Physics II (GIR); 18.03; 2.004*                                                    |       |
| 2.72 Elements of Mechanical Design, 12; 2.005, 2.007, 2.671                                        |       |
| 2.793J Fields, Forces and Flows in Biological Systems, 12; 2.005, 6.021, 20.320, or permission of instructor |       |
| 2.797 Molecular, Cellular, and Tissue Biomechanics, 12; 18.03 or 3.016; Biology (GIR); 2.370 or 2.772 |       |
| 2.813 Environmentally Benign Design and Manufacturing, 12; 2.008 or permission of instructor        |       |
| 2.96 Management in Engineering, 12                                                                |       |

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<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th>(36)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Unrestricted Electives(a)</th>
<th>48</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Total Units Beyond the GIRs Required for SB Degree</th>
<th>195</th>
</tr>
</thead>
</table>

No subject can be counted both as part of the 17-subject GIRs and as part of the 195 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes
*Alternate prerequisites or corequisites are listed in the subject description.

(a) To encourage more substantial research, design, or independent study, the department permits up to 15 units of 2.016 U credit, subject to approval of the student’s thesis advisor.

(b) The department suggests that students elect a basic electronics subject (e.g., 6.002 or 6.071) as early as possible in their program.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
# Bachelor of Science in Engineering as recommended by the Department of Mechanical Engineering/Course 2-A

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 2.001 and 18.03 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [satisfied by 2.671 in the Departmental Program]</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

## Communication Requirement
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M) [satisfied by 2.009 and 2.671 in the Departmental Program].

## PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

### Required Departmental Core Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.001 Mechanics and Materials I, 12, REST; Physics I (GIR), Calculus II (GIR), 18.03</td>
<td>75</td>
</tr>
<tr>
<td>2.003 Dynamics and Control I, 12, REST; Physics II (GIR), Calculus II (GIR), 18.03</td>
<td></td>
</tr>
<tr>
<td>2.005 Thermal-Fluids Engineering I, 12, REST; Physics II (GIR), Calculus II (GIR), 18.03</td>
<td></td>
</tr>
<tr>
<td>2.009 The Product Engineering Process, 12, CI-M; 2.001, 2.003J, 2.005, 2.670 or 2.008; senior standing or permission of instructor</td>
<td></td>
</tr>
<tr>
<td>2.670 Mechanical Engineering Tools, 3</td>
<td></td>
</tr>
<tr>
<td>2.671 Measurement and Instrumentation, 12, LAB, CI-M; 2.001, 2.003J, Physics II (GIR)</td>
<td></td>
</tr>
<tr>
<td>18.03 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
</tbody>
</table>

### Two Additional Mechanical Engineering Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.002 Mechanics and Materials II, 12; 2.001, Chemistry (GIR)</td>
<td>24</td>
</tr>
<tr>
<td>2.003 Dynamics and Control II, 12, 2.003J, Physics II (GIR)</td>
<td></td>
</tr>
<tr>
<td>2.005 Thermal-Fluids Engineering II, 12, 2.005, 18.03</td>
<td></td>
</tr>
<tr>
<td>2.007 Design and Manufacturing I, 12; 2.001</td>
<td></td>
</tr>
<tr>
<td>2.008 Design and Manufacturing II, 12, 1/2 LAB; 2.001; 2.005; 2.007 or 2.017F</td>
<td></td>
</tr>
<tr>
<td>2.086 Numerical Computation for Mechanical Engineers, 12; 2.001, 2.003J, 2.005</td>
<td></td>
</tr>
<tr>
<td>2.ThU Undergraduate Thesis, 12</td>
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</tr>
</tbody>
</table>

### Elective Subjects with Engineering Content (1)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.004</td>
<td>72</td>
</tr>
</tbody>
</table>

### Departmental Program Units That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(36)</td>
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</tbody>
</table>

### Unrestricted Electives

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
</tr>
</tbody>
</table>

### Total Units Beyond the GIRs Required for SB Degree

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>183</td>
</tr>
</tbody>
</table>

*No subject can be counted both as part of the 17-subject GIRs and as part of the 183 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.*

### Notes

* Alternate prerequisites and corequisites are listed in the subject description.

(1) These electives define a concentrated area of study and must be chosen with the written approval of the ME Undergraduate Office. A minimum of 69 units of engineering topics must be included in the 72 units of concentration electives. Engineering topics are usually obtained from engineering courses, but in some cases, non-engineering subjects may be necessary for the particular engineering program defined by the concentration (e.g., management subjects for an engineering management concentration). In all cases, the relationship of concentration subjects to the theme of the concentration must be obvious. A thesis (2.ThU) of up to 12 units may be included among the concentration subjects if not already applied to the second-level requirement.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
### Bachelor of Science in Mechanical and Ocean Engineering/Course 2-OE

#### General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
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<tr>
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</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree:** 17

#### Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- 2 subjects designated as Communication Intensive in the Major (CI-M) (satisfied by 2.019 and 2.671 in the Departmental Program).

**PLUS Departmental Program**

**Units**

<table>
<thead>
<tr>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.001 Mechanics and Materials I</td>
<td>12</td>
</tr>
<tr>
<td>2.003 Dynamics and Control I</td>
<td>12</td>
</tr>
<tr>
<td>2.004 Dynamics and Control II</td>
<td>12</td>
</tr>
<tr>
<td>2.005 Thermal-Fluids Engineering I</td>
<td>12</td>
</tr>
<tr>
<td>2.012 Mechanics of Structures</td>
<td>12</td>
</tr>
<tr>
<td>2.016 Hydrodynamics</td>
<td>12</td>
</tr>
<tr>
<td>2.017J Design of Electromechanical Robotic Systems</td>
<td>12</td>
</tr>
<tr>
<td>2.018 Design of Ocean Systems</td>
<td>12</td>
</tr>
<tr>
<td>2.065 Acoustics and Sensing</td>
<td>12</td>
</tr>
<tr>
<td>2.092 Computer Methods in Dynamics</td>
<td>12</td>
</tr>
<tr>
<td>2.12 Introduction to Robotics</td>
<td>12</td>
</tr>
<tr>
<td>2.14 Analysis and Design of Feedback Control Systems</td>
<td>12</td>
</tr>
<tr>
<td>2.51 Intermediate Heat and Mass Transfer</td>
<td>12</td>
</tr>
<tr>
<td>2.60J Fundamentals of Advanced Energy Conversion</td>
<td>12</td>
</tr>
<tr>
<td>2.701 Principles of Naval Architecture</td>
<td>12</td>
</tr>
<tr>
<td>2.706 Sailing Vessel Design</td>
<td>12</td>
</tr>
<tr>
<td>2.866 Numerical Computation</td>
<td>12</td>
</tr>
<tr>
<td>2.612 Marine Power and Propulsion</td>
<td>12</td>
</tr>
<tr>
<td>2.670 Mechanical Engineering Tools</td>
<td>3</td>
</tr>
<tr>
<td>2.701 Principles of Naval Architecture</td>
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</tr>
<tr>
<td>2.706 Sailing Vessel Design</td>
<td>12</td>
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<tr>
<td>2.72 Elements of Mechanical Design</td>
<td>12</td>
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<tr>
<td>2.86 Management in Engineering</td>
<td>12</td>
</tr>
<tr>
<td>2.87 Undergraduate Thesis</td>
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**Required Departmental Subjects**

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</table>

**Restricted Elective Subjects**

2.006 Thermal Fluids Engineering II, 12; 2.005, 18.03
2.007 Design and Manufacturing I, 12; 2.001
2.008 Design and Manufacturing II, 12, 1/2 LAB; 2.001; 2.005; 2.007 or 2.017J
2.065 Acoustics and Sensing, 12; 2.003J, 6.003, 8.03, or 16.03
2.092 Computer Methods in Dynamics, 12; 2.001, 2.003J
2.12 Introduction to Robotics, 12; 2.004
2.14 Analysis and Design of Feedback Control Systems, 12; 2.004
2.51 Intermediate Heat and Mass Transfer, 12; 2.006*
2.60J Fundamentals of Advanced Energy Conversion, 12; 2.006*
2.701 Principles of Naval Architecture, 12; 2.002 or 2.012
2.706 Sailing Vessel Design, 12; 2.001 or permission of instructor
2.72 Elements of Mechanical Design, 12; 2.005, 2.007, 2.671
2.96 Management in Engineering, 12

**Departmental Program Units That Also Satisfy the GIRs**

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<td>2.87 Undergraduate Thesis</td>
<td>12</td>
</tr>
</tbody>
</table>

**Total Units Beyond the GIRs Required for SB Degree**

183

No subject can be counted both as part of the 17-subject GIRs and as part of the 183 units required beyond the GIRs. Every subject in the student’s Departmental Program will count toward one or the other, but not both.

**Notes**

*Alternate prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
3.003 Principles of Engineering Practice
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
1-2-6
Introduces students to the interdisciplinary nature of 21st-century engineering projects with three threads of learning: a technical toolkit, a social science toolkit, and a methodology for problem-based learning. Students encounter the social, political, economic, and technological challenges of engineering practice by participating in actual engineering projects involving public transportation and information infrastructure with faculty and industry. Student teams create prototypes and mixed media reports with exercises in project planning, analysis, design, optimization, demonstration, reporting and team building. Preference to freshmen.
L. Kimerling, R. Kirchain, C. Weaver, W. Uricchio, H. Einstein

3.012 Fundamentals of Materials Science and Engineering
Prereq: None. Coreq: 18.03, 18.034, or 3.016
U (Fall)
5-0-10 REST
Describes the fundamentals of structure and energetics that underpin materials science. Introduction to thermodynamic functions and laws governing equilibrium properties, relating macroscopic behavior to atomistic and molecular models of materials. Materials phenomena, such as heat capacities, phase transformations, multiphase equilibria, chemical reactions, and magnetism. Structure of noncrystalline, crystalline, and liquid-crystalline states. Symmetry and tensor properties of materials. Point, line, and surface imperfections in materials. Diffraction and structure determination. Real-world examples such as materials for fuel cells and batteries, engineered alloys, electronic and magnetic materials, ionic and network solids, polymers, and biomaterials. D. Irvine, F. Stellacci

3.014 Materials Laboratory
Prereq: None
U (Fall)
1-4-7 Institute LAB
Experimental exploration of the connections between energetics, bonding and structure of materials, and application of these principles in instruments for materials characterization. Demonstration of the wave-like nature of electrons. Hands-on experience with techniques to quantify energy (DSC), bonding (XPS, AES, FTIR, UV/vis and force spectroscopy), and degree of order (x-ray scattering) in condensed matter. Investigation of structural transitions and structure-property relationships through practical materials examples. Practice in oral and written technical communication. It is strongly recommended that 3.012 and 3.014 are taken simultaneously.
S. Gradečak, L. Hobbs, G. Beach

3.016 Mathematical Methods for Materials Scientists and Engineers
Prereq: Calculus II (GIR)
U (Fall)
3-1-8
Mathematical techniques necessary for materials science and engineering topics such as energetics, materials structure and symmetry, materials response to applied fields, mechanics and physics of solids and soft materials. Mathematical concepts and materials-related problem solving skills. Symbolic algebraic computational methods, programming, and visualization techniques. Topics include linear algebra, quadratic forms, tensor operations, symmetry operations, calculus of several variables, eigensystems, introduction to complex analysis, systems of ordinary and partial differential equations, phase plane analysis, beam theory, resonance phenomena, special functions, numerical solutions, statistical analysis, Fourier analysis, and random walks.
W. C. Carter

3.021 Introduction to Modeling and Simulation
Engineering School-Wide Elective Subject
(Offered under: 1.021, 3.021, 10.333, 22.00)
Prereq: 18.03, 3.016, or permission of instructor
U (Spring)
4-0-8 REST
Basic concepts of computer modeling and simulation in science and engineering. Uses techniques and software for simulation, data analysis and visualization. Continuum, mesoscale, atomistic and quantum methods used to study fundamental and applied problems in physics, chemistry, materials science, mechanics, engineering, and biology. Examples drawn from the disciplines above are used to understand or characterize complex structures and materials, and complement experimental observations.
M. Buehler, N. Marzari, R. Radovitzky, T. Thonhauser

3.022 Microstructural Evolution in Materials
Prereq: 3.012
U (Spring)
3-3-6
Covers microstructures, defects, and structural evolution in all classes of materials. Topics include solution kinetics, interface stability, dislocations and point defects, diffusion, surface energetics, grains and grain boundaries, grain growth, nucleation and precipitation, and electrochemical reactions. Lectures illustrate a range of examples and applications based on metals, ceramics, electronic materials, polymers, and biomedical materials. Explores the evolution of microstructure through experiments involving optical and electron microscopy, calorimetry, electrochemical characterization, surface roughness measurements, and other characterization methods. Investigates structural transitions and structure-property relationships through practical materials examples.
M. Cima, L. Hobbs, H. Tuller

3.024 Electronic, Optical and Magnetic Properties of Materials
Prereq: 3.012
U (Spring)
3-3-6
Describes how the electronic, optical and magnetic properties of materials originate from their electronic and molecular structure and how these properties can be designed for particular applications, for instance in optical fibers, magnetic data storage, solar cells, transistors and other devices. Experimental exploration of the electronic, optical and magnetic properties of materials. Includes hands-on experimentation using spectroscopy, resistivity, impedance and magnetometry measurements, behavior of light in waveguides, and other characterization meth-
ods. Investigation of structure-property relationships through practical materials examples.
Y. Fink, L. Hobbs, H. Tuller

3.032 Mechanical Behavior of Materials
Prereq: Physics I (GIR); 3.016 or 18.03
U (Fall)
4-2-6
Basic concepts of solid mechanics and mechanical behavior of materials, stress-strain relationships, stress transformation, elasticity, plasticity and fracture. Case studies include materials selection for bicycle frames, stress shielding in biomedical implants; residual stresses in thin films; and ancient materials. Lab experiments and demonstrations give hands-on experience of the physical concepts at a variety of length scales. Use of facilities for measuring mechanical properties including standard mechanical tests, bubble raft models, atomic force microscopy and nanoindentation.
A. Belcher, M. Rubner, K. J. Van Vliet

3.034 Organic and Biomaterials Chemistry
Prereq: 3.012
U (Fall)
4-2-6
Focuses on the chemistry and chemical structure-property relationships of soft synthetic and biologically derived materials. Topical coverage includes: methods for preparing synthetic polymers by step and chain growth polymerizations; polymerization reaction kinetics; chemistry of proteins, nucleic acids, polysaccharides and lipids, and their incorporation into biomaterials and biosensors; enzymatic reactions and ligations; chemical modification and patterning of organic and inorganic surfaces using organosilane and self-assembled monolayer chemistries, radiation grafting, physisorption and microcontact printing; organic systems as templates for inorganic materials; sol gel syntheses, polymer precursor conversions, polymer vesicle nanoreactors; chemical degradation of soft materials through readdition, hydrolysis, and thermolysis; electoreactive organic materials. First-hand application of lecture topics is obtained through design-oriented experiments.
A. Belcher, M. F. Rubner, K. Van Vliet

3.035, 3.036, 3.037 Special Problems in Materials Science and Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
3.038, 3.039, 3.04 Special Problems in Materials Science and Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
For undergraduates desiring to carry on projects of their own choosing, which may be experimental, theoretical, or of a design nature. Also for undergraduate studies arranged by students or staff, which may consist of seminars, assigned reading, or laboratory projects. See UROP Coordinator for registration procedures.
B. J. Wuensch

3.042 Materials Project Laboratory
Prereq: 3.014, 3.032, or 3.044
U (Fall, Spring)
1-6-5
Student project teams design and fabricate a materials engineering prototype using processing technologies (e.g., injection molding, thermoforming, investment casting, powder processing, three-dimensional printing, physical vapor deposition) appropriate for the materials and device of interest. Goals include using MSE fundamentals in a practical application; understanding trade-offs between design, processing and performance; and fabrication of a deliverable prototype. Emphasis on teamwork, project management, communications and computer skills, and hands-on work using student and MIT laboratory shops. Teams document their progress and final results by means of written and oral communication.
Fall: E. Thomas
Spring: Y. Chiang

3.044 Materials Processing
Prereq: 3.012, 3.022
U (Spring)
4-0-8
Introduction to materials processing science, with emphasis on heat transfer, chemical diffusion, and fluid flow. Uses an engineering approach to analyze industrial-scale processes, with the goal of identifying and understanding physical limitations on scale and speed. Covers materials of all classes, including metals, polymers, electronic materials, and ceramics. Considers specific processes, such as melt-processing of metals and polymers, deposition technologies (liquid, vapor, and vacuum), colloid and slurry processing, viscous shape forming, and powder consolidation.
C. Schuh

3.046 Thermodynamics of Materials
Prereq: 18.03, 18.034, or 3.016
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
4-0-8 REST
The laws of thermodynamics and their application to equilibrium and the properties of materials. Foundation to treat general phenomena in materials science and engineering, including chemical reactions, magnetism, polarizability, and elasticity. Relations pertaining to multi-phase equilibria as determined by a treatment of solution thermodynamics. Graphical constructions that are essential for the interpretation of phase diagrams. Electrochemical equilibria and surface thermodynamics. Aspects of statistical thermodynamics as they relate to macroscopic equilibrium phenomena.
W. C. Carter

3.048 Advanced Materials Processing
(Subject meets with 3.52J, 10.581J)
Prereq: 3.022, 3.044
U (Spring)
3-0-9
Fundamentals of materials processing. Building engineering structures from the atomic- and nano-scales to macroscopic levels. Case studies illustrating application of processing science to creation of modern metallic, ceramic, polymeric and biomaterials devices and components.
Staff

3.051 Materials for Biomedical Applications
(Subject meets with 20.340J)
Prereq: Chemistry (GIR), Biology (GIR), 3.034, 3.012 or 3.046; or permission of instructor
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9
D. Irvine
3.052 Nanomechanics of Materials and
Biomaterials
Prereq: 3.032 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9
Latest scientific developments and discoveries in the field of nanomechanics, i.e. the deformation of extremely tiny (10-9 meters) areas of synthetic and biological materials. Lectures include a description of normal and lateral forces at the atomic scale, atomistic aspects of adhesion, nanoindentation, molecular details of fracture, chemical force microscopy, elasticity of individual macromolecular chains, intermolecular interactions in polymers, dynamic force spectroscopy, biomolecular bond strength measurements, and molecular motors.
C. Ortiz

3.053J Molecular, Cellular, and Tissue
Biomechanics
(3.053J, 3.054J, 3.055J, 3.056J)
Prereq: 2.370 or 2.772J; 18.03 or 3.016; Biology (GIR)
U (Spring)
4-0-8
See description under subject 2.797J.
R. D. Kamm

3.063 Polymer Physics
Prereq: 3.012
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
4-0-8
The mechanical, optical, electrical, and transport properties of polymers and other types of “soft matter” are presented with respect to the underlying physics and physical chemistry of polymers and colloids in solution, and solid states. Topics include how enthalpy and entropy determine conformation, molecular dimensions and packing of polymer chains and colloids and supramolecular materials. Examination of the structure of glassy, crystalline, and rubbery elastic states of polymers; thermodynamics of solutions, blends, crystallization; liquid crystallinity, microphase separation, and self-assembled organic-inorganic nanocomposites. Case studies of relationships between structure and function in technologically important polymeric systems.
E. L. Thomas, A. Alexander-Katz

3.064 Polymer Engineering
Prereq: 3.032, 3.044
U (Fall)
3-0-9
Overview of engineering analysis and design techniques for synthetic polymers. Treatment of materials properties selection, mechanical characterization, and processing in design of load-bearing and environment-compatible structures.
D. K. Roylance

3.07 Introduction to Ceramics
Prereq: 3.012
U (Fall)
3-0-9
Discusses structure-property relationships in ceramic materials. Includes hierarchy of structures from the atomic to microstructural levels. Defects and transport, solid-state electrochemical processes, phase equilibria, fracture and phase transformations are discussed in the context of controlling properties for various applications of ceramics. Numerous examples from current technology.
Y. Chiang

3.070J Communicating About Technology:
Colossal Failures in Engineering
(Same subject as 1.588J, 22.002J, 21W.781J, ESD.032J)
Prereq: None
U (Spring)
3-0-9 HASS, CI-H
See description under subject 21W.781J.
T. Eagar, W. Haas, A. Kadak, P. Lagacé, O. Buyukozturk

3.072 Symmetry, Structure and Tensor
Properties of Materials
(Subject meets with 3.60)
Prereq: 3.016 or 18.03
U (Fall)
4-0-8
Derivation of symmetry theory; lattices, point groups, space groups, and their properties. Use of symmetry in tensor representation of crystal properties, including anisotropy, representation surfaces, as well as applications to piezoelectricity and elasticity.
B. J. Wuensch

3.073 Diffraction and Structure
(Subject meets with 3.271)
Prereq: 18.03, 3.024
U (Spring)
4-0-8
B. J. Wuensch

3.074 Imaging of Materials
(Subject meets with 3.34)
Prereq: 3.024, 3.073, or permission of instructor
U (Spring)
3-0-9
Principles and applications of imaging techniques for materials characterization including transmission and scanning electron microscopy and scanning probe microscopy. Topics include electron diffraction; image formation in transmission and scanning electron microscopy; diffraction and phase contrast; imaging of crystals and crystal imperfections; review of the most recent advances in electron microscopy for bio- and nanosciences; analysis of chemical composition and electronic structure at the atomic scale. Lectures, real-case studies and computer simulations.
S. Gradečak

3.080 Economic and Environmental Materials
Selection
Prereq: 3.012, 3.014, 3.022, 3.024, or permission of instructor
U (Fall)
3-0-9
Provides a survey of methods for evaluating choice of material and explores the implications of that choice. Topics include choice of materials, manufacturing economics, and life-cycle environmental evaluation. Students carry out a group project selecting materials technology options based on economic and environmental characteristics.
R. Kirchain
3.083J Fundamentals of Advanced Energy Conversion
(Subject meets as 2.60J)
Prereq: 2.006, 3.044, or permission of instructor
U (Spring) 4-0-8

See description under subject 2.60J.
A. F. Ghoniem, M. Kazimi, Y. Chiang

3.091 Introduction to Solid-State Chemistry
Prereq: None
U (Fall, Spring) 5-0-7 CHEMISTRY

Basic principles of chemistry and their application to engineering systems. The relationship between electronic structure, chemical bonding, and atomic order. Characterization of atomic arrangements in crystalline and amorphous solids: metals, ceramics, semiconductors, and polymers (including proteins). Topical coverage of organic chemistry, solution chemistry, acid-base equilibria, electrochemistry, biochemistry, chemical kinetics, diffusion, and phase diagrams. Examples from industrial practice (including the environmental impact of chemical processes), from energy generation and storage (e.g. batteries and fuel cells), and from emerging technologies (e.g. photonic and biomedical devices).

Fall: D. R. Sadownik
Spring: D. Paul

3.094 Materials in Human Experience
Prereq: None
U (Spring) 2-3-4 HASS

Examines the ways in which people in ancient and contemporary societies have selected, evaluated, and used materials of nature, transforming them to objects of material culture. Some examples: glass in ancient Egypt and Rome; sounds and colors of powerful metals in Mesoamerica; cloth and fiber technologies in the Inca empire. Explores ideological and aesthetic criteria often influential in materials development. Laboratory/workshop sessions provide hands-on experience with materials discussed in class. Subject complements 3.091. Enrollment may be limited.

D. Hosler, L. W. Hobbs, H. N. Lechtman

3.14 Physical Metallurgy
(Subject meets with 3.40J, 22.71J)
Prereq: 3.012, 3.022, 3.032
U (Fall) 3-0-9

Focuses on the links between the processing, structure, and properties of metals and alloys. First, the physical bases for strength, stiffness, and ductility are discussed with reference to crystallography, defects, and microstructure. Second, phase transformations and microstructural evolution are studied in the context of alloy thermodynamics and kinetics. Together, these components comprise the modern paradigm for designing metallic microstructures for optimized properties. Concludes with a focus on processing/microstructure/property relationships in structural engineering alloys, particularly steels and aluminum alloys. Students taking the graduate version explore the subject in greater depth.

C. Schuh

3.15 Electrical, Optical, and Magnetic Materials and Devices
Prereq: 3.024
U (Fall) 4-0-8

Explores the relationships between the performance of electrical, optical, and magnetic devices and the microstructural characteristics of the materials from which they are constructed. Features a device-motivated approach that places strong emphasis on emerging technologies. Applications include diodes, transistors, photodetectors, solar cells (photovoltaics), displays, light emitting diodes, lasers, optical fibers and optical communications, photonic devices, magnetic data storage and spintronics.

C. A. Ross

3.155J Micro/Nano Processing Technology
(Subject meets as 6.152J)
Prereq: Permission of instructor
U (Fall, Spring) 3-4-5

See description under subject 6.152J.

3.172 Inventions and Patents
Engineering School-Wide Elective Subject
(Offered under: 3.172, 6.901, 16.652)
Prereq: 14.02
U (Fall) 3-0-6

History of private and public rights in scientific discoveries and applied engineering, leading to the development of worldwide patent systems. The classes of invention protectable under the patent laws of the US, including the procedures in protecting inventions in the Patent Office and the courts. Reviews of past cases involving inventions and patents in (a) the chemical process industry and medical pharmaceutical, biological, and genetic-engineering fields; (b) devices in the mechanical, ocean exploration, civil, and/or aeronautical fields; (c) the electrical, computer, software, and electronic areas, including key radio, solid-state, computer and software inventions; and also (d) software protection afforded under copyright laws. Conducting periodic joint real-time class sessions and discussions by video-audio Internet conferencing, with other universities. Enrollment limited.

R. H. Rines

3.20 Materials at Equilibrium
Prereq: 3.012, 3.014, 3.022, 3.024, 3.034, and 3.042; or permission of instructor
G (Fall) 5-0-10 H-LEVEL Grad Credit


G. Ceder, A. Alexander-Katz
3.201 Advanced Engineering Internship  
Prereq: Permission of instructor  
G (IAP, Spring, Summer)  
4-0-8 H-LEVEL Grad Credit  
Can be repeated for credit  
Provides academic credit for students in the Course 3 MEng program for approved off-campus work assignments in industry. Students participate in engineering projects and technology assessment under the supervision of a departmental faculty advisor.  
Staff

3.202 Advanced Industrial Internship  
Technology Development  
Prereq: 3.15  
G (IAP, Spring, Summer)  
4-0-8 H-LEVEL Grad Credit  
Students explore in-depth projects on a particular materials-based technology. Students are expected to investigate the science and technology of materials advances and their strategic value; explore potential applications for fundamental advances; and determine intellectual property related to the materials technology and applications. Students map progress with presentations, and are expected to create an end-of-term document enveloping technology, intellectual property, applications, and potential commercialization. In addition to lectures, outside speakers present their expertise in technology, entrepreneurship, intellectual property, and commercialization of materials technologies. All lectures and speaker’s presentations are videotaped, digitized and put on the web for internship students to view. Registration is restricted to students enrolled in the Course 3 MEng Program who are off-campus working at an industrial site.  
E. A. Fitzgerald

3.205 Thermodynamics and Kinetics of Materials  
Prereq: 3.022, 3.042  
G (Fall)  
4-0-8 H-LEVEL Grad Credit  
T. Eagar, K. Russell

3.206 Introduction to Materials Engineering Practice  
Prereq: Chemistry (GIR)  
G (Fall)  
1-0-2 H-LEVEL Grad Credit  
Introduction to methods of technology research and development in materials-based fields. Seminar-based methodology, employing speakers from inside and outside MIT.  
G. Fitzgerald

3.207 Technology Development and Evaluation  
Prereq: 3.024, 3.15  
G (Spring)  
4-0-8 H-LEVEL Grad Credit  
Students explore in-depth projects on a particular materials-based technology. Students are expected to investigate the science and technology of materials advances and their strategic value; explore potential applications for fundamental advances; and determine intellectual property related to the materials technology and applications. Students map progress with presentations, and are expected to create an end-of-term document enveloping technology, intellectual property, applications, and potential commercialization. In addition to classroom lectures, outside speakers present their expertise in technology, entrepreneurship, intellectual property, and commercialization of materials technologies.  
E. A. Fitzgerald

3.21 Kinetic Processes in Materials  
Prereq: 3.012, 3.022, 3.044, or permission of instructor  
G (Spring)  
5-0-10 H-LEVEL Grad Credit  
Unified treatment of phenomenological and atomistic kinetic processes in materials. Provides the foundation for the advanced understanding of processing, microstructural evolution, and behavior for a broad spectrum of materials. Emphasis on analysis and development of rigorous comprehension of fundamentals. Topics include: irreversible thermodynamics; diffusion; nucleation; capillarity; grain growth; phase transformations; and morphological instabilities; gas-solid, liquid-solid, and solid-solid reactions.  
S. M. Allen

3.22 Mechanical Behavior of Materials  
Prereq: 3.032  
G (Spring)  
4-0-8 H-LEVEL Grad Credit  
Explores how the macroscale mechanical behavior of materials originates from fundamental, microscale mechanisms of elastic and inelastic deformation. Topics include: elasticity, viscoelasticity, plasticity, creep, fracture, and fatigue. Case studies and examples are drawn from a variety of material classes: metals, ceramics, polymers, thin films, composites, and cellular materials.  
M. J. Demkowicz

3.225 Electronic and Mechanical Properties of Materials  
Prereq: 8.03, 3.032  
G (Fall)  
4-0-8 H-LEVEL Grad Credit  
Electrical, optical, magnetic, and mechanical properties of metals, semiconductors, ceramics and polymers. Discussion of roles of bonding, structure (crystalline, defect, energy band and microstructure) and composition in influencing and controlling physical properties. Case studies drawn from a variety of applications including semiconductor diodes, optical detectors, sensors, thin films, biomaterials, composites, and cellular materials.  
D. Paul, D. Roylance

3.23 Electrical, Optical, and Magnetic Properties of Materials  
Prereq: 8.03, 18.03  
G (Fall)  
4-0-8 H-LEVEL Grad Credit  
Origin of electrical, magnetic and optical properties of materials. Focus on the acquisition of quantum mechanical tools. Analysis of the properties of materials. Presentation of the postulates of quantum mechanics. Examination of the hydrogen atom, simple molecules and bonds, and the behavior of electrons in solids and energy bands. Introduction of the variation principle as a method for the calculation of wavefunctions. Investigation of how and why materials respond to different electrical, magnetic and electromagnetic fields and probes. Study of the conductivity, dielectric function, and magnetic permeability in metals, semiconductors, and insulators. Survey of common devices such as transistors, magnetic storage media, optical fibers.  
S. Lipson

3.271 Diffraction and Structure  
(Subject meets with 3.073)  
Prereq: 18.03, 3.024  
G (Spring)  
4-0-8 H-LEVEL Grad Credit  
Describes x-ray and neutron diffraction using Laue equations, Bragg’s law, and the reciprocal lattice. Use of Fourier transforms and series to establish relations between intensity and distribution of scattering density. Applications to

B. J. Wuensch

3.29 Special Problems in Emerging and Fundamental Studies in Materials
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

3.291 Special Problems in Emerging and Fundamental Studies in Materials
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Advanced work in the field for qualified students. Lectures, conferences, assigned readings, or supervised laboratory work.

G. Ceder

3.320 Atomistic Computer Modeling of Materials
Prereq: 3.022, 3.20, 3.23 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

G. Ceder

3.34 Imaging of Materials
(Subject meets with 3.074)
Prereq: 3.23 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Principles and applications of imaging techniques for materials characterization including transmission and scanning electron microscopy and scanning probe microscopy. Topics include electron diffraction; image formation in transmission and scanning electron microscopy; diffraction and phase contrast; imaging of crystals and crystal imperfections; review of the most recent advances in electron microscopy for bio- and nanosciences; analysis of chemical composition and electronic structure at the atomic scale. Lectures, real-case studies and computer simulations. Graduate students complete additional assignments.

S. Gradečak

3.35 Fracture and Fatigue
Prereq: 3.032
G (Fall)
3-0-9 H-LEVEL Grad Credit

S. Suresh

3.37 Welding and Joining Processes
(Subject meets with 2.821J, 3.371J)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
3-0-3 H-LEVEL Grad Credit
Discusses a wide variety of processes and materials from the viewpoint of their fundamental physical and chemical properties. Specific topics: cold welding, adhesive bonding, diffusion bonding, soldering, brazing, flames, arcs, high-energy density heat sources, solidification, cracking resistance, shielding methods, and electric contacts. Emphasis on underlying science of a given process rather than a detailed description of the technique or equipment. Meets with first half of subject 3.371J in Fall Term; videotaped instruction.

T. W. Eagar

3.371J Fabrication Technology
(Subject meets with 2.821J)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
4-0-5 H-LEVEL Grad Credit
Discusses a wide variety of technologies including welding, brazing, soldering, casting, forging and non-destructive testing, especially as related to ship building and heavy fabrication. Emphasis on the underlying science of a given process rather than a detailed description of the technique or equipment. First half of subject meets with subject 3.37 in Fall Term; videotaped instruction in other terms.

T. W. Eagar

3.40J Modern Physical Metallurgy
(Subject meets with 22.71J)
(Subject meets with 3.14)
Prereq: 3.012, 3.022, 3.032
G (Fall)
3-0-9 H-LEVEL Grad Credit
Examines how the presence of 1-, 2- and 3-D defects and second phases control the mechanical, electromagnetic and chemical behavior of metals and alloys. Considers point, line and interfacial defects in the context of structural transformations including annealing, spinodal decomposition, nucleation, growth, and particle coarsening. Concentrates on structure-function relationships, and in particular how grain size, interstitial and substitutional solid solutions, and second-phase particles impact mechanical and other properties. Industrially relevant case studies illustrate lecture concepts. Students taking the graduate version explore the subject in greater depth.

C. Schuh

3.42 Electronic Materials Design
Prereq: 3.23
G (Fall)
3-0-9 H-LEVEL Grad Credit
Extensive and intensive examination of structure-processing-property correlations for a wide range of materials including metals, semiconductors, dielectrics, and optical materials. Topics covered include defect equilibria; junction characteristics; photodiodes, light sources and displays; bipolar and field effect transistors; chemical, thermal and mechanical transducers; data storage. Emphasis on materials design in relation to device performance.

H. L. Tuller

3.43J Integrated Microelectronic Devices
(Subject meets with 6.720J)
Prereq: 6.012 or 3.42
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 6.720J.

J. A. del Álamo, H. L. Tuller

3.44 Materials Processing for Micro- and Nano-Systems
Prereq: 3.205 and 3.225; or 3.20 and 3.21
G (Fall)
3-0-9 H-LEVEL Grad Credit
Processing of bulk, thin film, and nanoscale materials for applications in electronic, magnetic,
electromechanical, and photonic devices and microsystems. Topics include growth of bulk, thin-film, nanoscale single crystals via vapor and liquid phase processes; formation, patterning and processing of thin films, with an emphasis on relationships among processing, structure, and properties; and processing of systems of nanoscale materials. Examples from materials processing for applications in high-performance integrated electronic circuits, integrated sensors, and data storage systems.

C. V. Thompson

3.45 Magnetic Materials
Prereq: 3.23
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Foundation topics include magnetostatics, origin of magnetism in materials, magnetic domains and domain walls, magnetic anisotropy, reversible and irreversible magnetization processes; hard and soft magnetic materials and magnetic recording. Special topics are selected from magnetism at nanoscale (thin films, surfaces, particles); amorphous and nanocrystalline magnetic materials; electronic transport in ferromagnets including magnetoresistive, spin-valve and spin-tunnel junction sensors.

Staff

3.46 Photonic Materials and Devices
Prereq: 3.42
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit


L. C. Kimerling

3.47 Processing of Materials on the Nanoscale
Prereq: 3.20 and 3.21; or 3.205 and 3.44
G (Spring)
3-0-9 H-LEVEL Grad Credit

Coverage includes techniques and underlying principles for synthesis and assembly of materials with one or more nanoscale dimensions, in the form of individual molecules, dots, wires, tubes, or sheets. Focuses on materials with applications arising from size-dependent electronic, magnetic, phononic, chemical, or mechanical properties. Synthesis via both physical processes (e.g. lithography, physical vapor deposition) and chemical processes (e.g. chemical vapor deposition, growth from liquid and solid solutions) are discussed. Thermodynamically-driven and kinetically-driven self-assembly processes are described as illustrations of fundamental assembly mechanisms. The formation of hierarchical ordered structures by templated self assembly are also discussed. Lectures complemented by case studies given by the instructors and by outside speakers.

C. A. Ross, C. V. Thompson

3.48) Materials and Processes for Microelectromechanical Devices and Systems
(Same subject as 2.373J, 6.778J, 10.584J, 16.288J)
Prereq: 6.152J/3.155J; permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Unified treatment of key principles in materials and processing for design and manufacture of microelectromechanical systems (MEMS). Emphasis on materials and processes commonly used for fabrication for MEMS and not microelectronic systems. Discussion of the processing and properties of both thin and thick polycrystalline and amorphous films, wafer and thin film bonding, bulk micromachining techniques, and the relationships between processing and properties of active materials such as piezoelectrics, ferroelectrics and phase-transition materials. Key material properties and parameters and their relationships with microfabrication processes and applications are discussed, including elastic and inelastic deformation, fracture, residual stress, fatigue, creep, adhesion, stiction, and coupled-field constitutive behavior. Materials and process selection and case studies of applications provide a unifying theme.

L. Anand, K. F. Jensen, M. A. Schmidt, C. V. Thompson, B. L. Wardle

3.49 Special Problems in Electronic, Photonic and Magnetic Materials
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Can be repeated for credit

3.491 Special Problems in Electronic, Photonic and Magnetic Materials
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Can be repeated for credit

Advanced work for qualified students. Lectures, conferences, assigned readings, or supervised laboratory work.

F. Stellacci

3.52J Advanced Materials Processing
(Same subject as 10.581J)
(Subject meets with 3.048)
Prereq: 3.022, 3.044
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Fundamentals of materials processing. Building engineering structures from the atomic- and nano-scales to macroscopic levels. Case studies illustrating application of processing science to creation of modern metallic, ceramic, polymeric and biomaterials devices and components.

C. Schuh, M. C. Flemings

3.53 Electrochemical Processing of Materials
Prereq: 3.044
G (IAP)
3-0-6 H-LEVEL Grad Credit


D. R. Sadoway

3.54J Corrosion: The Environmental Degradation of Materials
(Same subject as 22.72J)
Prereq: 3.012
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Applies thermodynamics and kinetics of electrode reactions to aqueous corrosion of metals and alloys. Application of advanced computa-
3.56 Engineering Systems Analysis for Design
Engineering School-Wide Elective Subject
(Offered under: 1.146, 3.56, 16.861, ESD.71)
Prereq: 1.145J or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject ESD.71.
R. de Neufville

3.560J Industrial Ecology
(Same subject as 1.814J, ESD.123)
Prereq: ESD.10 or 3.56
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject ESD.123.
R. Kirchain, J. Clark, F. Field

3.57J Materials Selection, Design, and Economics
(Same subject as ESD.73J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
A survey of techniques for analyzing how the choice of materials, processes, and design determine properties, performance, and cost. Topics include production and cost functions, mathematical optimization, evaluation of single and multi-attribute utility, decision analysis, materials property charts, and performance indices. Students use analytical techniques to develop a plan for starting a new materials-related business.
J. Clark

3.575J Materials Selection, Design, and Economics
(Same subject as ESD.730J)
Prereq: Permission of instructor
G (Summer)
2-0-4 H-LEVEL Grad Credit
See description under subject ESD.730J.
J. P. Clark

3.577 Engineering Risk-Benefit Analysis
Engineering School-Wide Elective Subject
(Offered under: 1.155, 2.963, 3.577, 6.938, 10.816, 16.862, 22.82, ESD.72)
Prereq: Calculus II (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.72.
G. E. Apostolakis

3.595 Special Problems in Structural and Environmental Materials
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
3.596 Special Problems in Structural and Environmental Materials
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Advanced work in the field for qualified students. Lectures, conferences, assigned readings, or supervised laboratory work.
H. Tuller

3.60 Symmetry, Structure, and Tensor Properties of Materials
(Subject meets with 3.072)
Prereq: 3.016 or 18.03
G (Fall)
4-0-8 H-LEVEL Grad Credit
Derivation of symmetry theory; lattices, point groups, space groups, and their properties. Use of symmetry in tensor representation of crystal properties, including anisotropy, representation surfaces, as well as applications to piezoelectricity and elasticity.
B. J. Wuensch

3.64J Fundamentals of Advanced Energy Conversion
(Subject meets with 3.62J, 10.392J, 15.792J, 3.083J)
Prereq: 3.006, 3.044, or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
See description under subject 2.62J.
A. F. Ghoniem, M. Kazimi, Y. Chiang

3.69 Teaching Fellows Seminar
Prereq: None
G (Fall)
2-0-1
Can be repeated for credit
Provides instruction to help prepare students for teaching at an advanced level. Topics include preparing a syllabus, selecting a textbook, scheduling assignments and examinations, lecture preparation, “chalk and talk” vs. electronic presentations, academic honesty and discipline, preparation of examinations, grading practices, working with teaching assistants, and working with colleagues.
C. Schuh, E. Thomas

3.691–3.699 Teaching Materials Science and Engineering
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit
Laboratory, tutorial, or classroom teaching under the supervision of a faculty member. Students selected by interview. (Enrollment limited by availability of suitable teaching assignments.)
H. Tuller

3.80J Proseminar in Manufacturing
(Same subject as 2.890J, 10.792J, 15.792J, 16.985J)
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
See description under subject 15.792J.
D. B. Rosenfield

3.901 Special Problems in Bio and Polymeric Materials
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
3.902 Special Problems in Bio and Polymeric Materials
Prereq: Permission of instructor
G (Fall, IAP, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Advanced work in the field. Lectures, conferences, assigned readings, and laboratory work.
M. Cima
3.903J Student Seminar in Polymer Science and Technology
( Same subject as 10.960J)
Prereq: None
G (Fall, Spring)
2-0-0 [P/D/F]
Can be repeated for credit
See description under subject 10.960J.
G. H. McKinley, P. S. Doyle, K. Van Vliet, D. Irvine

3.91 Mechanical Behavior of Polymers
Prereq: Introductory subjects in solid mechanics and polymers recommended (e.g. 3.032, 3.034)
G (Spring)
3-0-9 H-LEVEL Grad Credit
Influence of processing and structure on mechanical properties of synthetic and natural polymers: Hookean and entropic elastic deformation, linear viscoelasticity, composite materials and laminates, yield and fracture.
D. K. Roylance

3.930 Industrial Practice
Prereq: None
U (Summer)
0-6-0 [P/D/F]
Provides academic credit for first approved work assignment at a company. For reporting requirements, consult faculty industrial practice coordinator. Enrollment restricted to students in Course 3.
C. A. Ross

3.931 Industrial Practice
Prereq: None
U (Summer)
0-6-0
Enrollment restricted to students in Course 3.
Provides academic credit for second approved work assignment at a company in the year following completion of 3.930. For reporting requirements consult faculty industrial practice coordinator.
C. A. Ross

3.932 Industrial Practice
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Provides academic credit for graduate students in Course 3B for approved work assignments at companies.
S. M. Allen

3.94 Morphology of Polymers
Prereq: 3.063
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-6
Structure of noncrystalline, crystalline, and liquid crystalline polymers, including polymers blends, and block copolymers. Texture development from processing operations, mechanical deformation, and applied electric and magnetic fields. Hybrid organic-inorganic nano and microcomposites. Phase transformations, including classical nucleation theory and spinodal decomposition. Use of morphological characterization methods such as wide- and small-angle x-ray scattering and scanning, transmission electron microscopy and atomic force microscopy are also covered.
E. L. Thomas

3.941J Statistical Mechanics of Polymers
( Same subject as 10.668J)
Prereq: 10.568 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 10.668J.
G. C. Rutledge, P. S. Doyle

3.96 J Biomaterials: tissue interactions
( Same subject as 2.79J, 20.441J, HST.522J)
Prereq: Chemistry (GIR); 2.005 or 5.60; Biology (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.441J.
I. V. Yannas, M. Spector

3.961 J Design of Medical Devices and Implants
( Same subject as 2.782J, 20.451J, HST.524J)
Prereq: 2.79J or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.782J.
I. V. Yannas, M. Spector

3.962 J Molecular Principles of Biomaterials
( Same subject as 20.462J)
( Subject meets with 3.051J, 20.340J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.462J.
Staff

3.97 J Cell-Matrix Mechanics
( Same subject as 2.785J, 20.411J, HST.523J)
Prereq: 2.005 or 5.60; Biology (GIR); Chemistry (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.785J.
I. V. Yannas, M. Spector

3.971J Molecular, Cellular, and Tissue Biomechanics
( Same subject as 2.798J, 6.524J, 10.537J, 20.410J)
Prereq: Biology (GIR); 2.002, 2.006, 6.013, 10.301, or 10.302
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.410J.
A. J. Grodzinsky, M. Bathe

3.98 Polymer Synthetic Chemistry
Prereq: any basic polymer chemistry subject
G (Spring)
3-0-6 H-LEVEL Grad Credit
An examination of the fundamental reaction mechanisms and chemistry of polymerization reactions with an emphasis on the synthesis of new advanced polymers and their properties.
M. F. Rubner

ARCHAEOLOGY AND ARCHAEOLOGICAL SCIENCE

3.982 The Ancient Andean World
Prereq: None
U (Fall)
3-0-6 HASS
Examines development of Andean civilization which culminated in the extraordinary empire established by the Inka. Archaeological, ethnographic, and ethnohistorical approaches. Particular attention to the unusual topography of the Andean area, its influence upon local ecology, and the characteristic social, political, and technological responses of Andean people to life in a topographically "vertical" world. Characteristic cultural styles of prehistoric Andean life.
H. N. Lechtman
3.983 Ancient Mesoamerican Civilization
Prereq: None
U (Spring)
3-0-6 HASS
Examines origins, florescence and collapse of selected civilizations of ancient Mesoamerica using archaeological and ethnohistorical evidence. Focus on Olmec, Maya, Teotihuacan and Aztec, considering key technological, environmental, social organizational and ideological variables. Investigates contacts between South America and Western Mexico.
D. Hosler

3.984 Materials in Ancient Societies: Ceramics
Prereq: Permission of instructor
G (Fall)
3-6-3
Seminars and labs provide in-depth study of the technologies ancient societies used to produce objects from ceramic materials, including clays and mortars. Seminars cover basic ceramic materials science and engineering and relate materials selection and processing to environment, exchange, political power, and cultural values. Seniors may register for subject under special topics number: consult instructor.
H. N. Lechtman; L. Hobbs

3.985] Archaeological Science
(Same subject as 5.24, 12.011)
Prereq: Chemistry (GIR) or Physics I (GIR)
U (Spring)
3-1-5 HASS
Pressing issues in archaeology as an anthropological science. Stresses the natural science and engineering methods archaeologists use to address these issues. Reconstructing time, space, and human ecologies provides one focus; materials technologies that transform natural materials to material culture provide another. Topics include 14C dating, ice core and palynological analysis, GIS and other remote sensing techniques for site location, soil micromorphology and site formation, sourcing of metal artifacts, and microstructural and mechanical analyses of cementitious materials used in ancient monumental buildings.
H. N. Lechtman, J. Stubbe, F. A. Frey

3.986 The Human Past: Introduction to Archaeology
Prereq: None
U (Fall)
3-2-7 HASS-D, Category 4
Archaeology reconstructs ancient human activities and their environmental contexts. Examines these activities and the forces that shaped them, drawing on case studies in contrasting environmental settings from the Near East and Mesoamerica. In laboratory sessions, students learn to manage various classes of archaeological data and analyze archaeological artifacts made from materials such as stone, bone, and ceramics. These analyses help reconstruct the past.
H. V. Merrick

3.987 Human Origins and Evolution
Prereq: None
U (Spring)
3-0-6 HASS
Examines the dynamic interrelations among physical and behavioral traits of humans and environment and culture to provide an integrated framework for studying human biological evolution and modern diversity. Topics include issues in morphological evolution and adaptation; fossil and cultural evidence for human evolution from earliest times through the Pleistocene; evolution of tool use and social behavior; modern human variation and concepts of race. Includes study of stone artifacts and fossil specimens.
H. V. Merrick

3.988 Africa—Past and Present: An Archaeological and Ethnographic Materials Perspective
Prereq: None
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-6 HASS
Examines prehistory and modern ethnographic diversity of technology on the African continent, with particular emphasis on the sub-Saharan region. Traces the course of human technological evolution from the earliest Plio-Pleistocene tool-making hominids to the modern ethnically diverse inhabitants of the continent, by way of topical case studies. These cases are centered on subsistence adaptations and technological responses. Includes lectures, experience handling prehistoric stone artifacts and modern ethnographic items, and ethnographic films.
H. V. Merrick

3.989 Materials in Ancient Societies: Ceramics Laboratory
Prereq: Permission of instructor
G (Spring)
3-6-3
Laboratory analysis of archaeological artifacts of ceramics. Follows on 3.984.
H. N. Lechtman, L. Hobbs

3.990 Seminar in Archaeological Method and Theory
Prereq: 3.986, 3.985J, 21A.100
U (Fall, Spring)
3-0-6
Designed for undergraduate seniors majoring in Archaeology and Materials. Critical analysis of major intellectual and methodological developments in American archaeology, including evolutionary theory, the “New Archaeology,” Marxism, formal and ideological approaches. Explores the use of science and engineering methods to reconstruct cultural patterns from archaeological data. Seminar format, with formal presentations by all students. Non-majors fulfilling all prerequisites may enroll by permission of instructors. Instruction and practice in oral and written communication provided.
D. Hosler, H. Lechtman, H. Merrick

3.993 Archaeology of the Middle East
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-6 HASS
Focus on the rise of settled communities, cities, and empires and their technological achievements in various areas of the Middle East including Anatolia, the Levant, and Mesopotamia. Using archaeological and written sources, examines why such complex societies arose in this area. Considers the technological basis of these societies; the role of temples and religious hierarchies, of crafts and trade in luxury goods, of writing and bureaucracies, and of class stratification in the rise of early civilizations.
H. Merrick

3.997 Graduate Fieldwork in Materials Science and Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of field research in materials science and engineering leading to the writing of an SM, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member.
D. Hosler, H. Lechtman
3.EPE UPOP Summer Practice Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 10.EPE, 16.EPE, 22.EPE)
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-1-0 [P/D/F]
Can be repeated for credit
See description under subject 2.EPE.
S. Luperfoy

3.EPR UPOP Reflective Learning Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPR, 2.EPR, 3.EPR, 6.EPR, 10.EPR, 16.EPR, 22.EPR)
Prereq: 2.EPE or permission of instructor
U (Fall)
0-0-3 [P/D/F]
See description under subject 2.EPR.
S. Luperfoy

3.EPW UPOP IAP Workshop
Engineering School-Wide Elective Subject
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW)
Prereq: None
U (IAP)
3-0-0 [P/D/F]
See description under subject 2.EPW.
S. Luperfoy

3.ThG Graduate Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research leading to the writing of an SM, MEng, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member.
C. Ortiz

3.ThU Undergraduate Thesis
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Program of research leading to the writing of an SB thesis; to be arranged by the student and an appropriate MIT faculty member. Instruction and practice in oral and written communication.
Consult C. A. Ross

3.URG Undergraduate Research
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Extended participation in work of a research group. Independent study of literature, direct involvement in group’s research (commensurate with student skills), and project work under an individual faculty member. See UROP coordinator for registration procedures.
B. J. Wuensch
## Bachelor of Science in Materials Science and Engineering/Course 3

### General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement in the Departmental Program</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement in the Departmental Program</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

### Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

### PLUS Departmental Program

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Subjects</strong></td>
<td><strong>128–138</strong></td>
</tr>
<tr>
<td>3.012 Fundamentals of Materials Science and Engineering</td>
<td>15, REST, 18.03*</td>
</tr>
<tr>
<td>3.014 Materials Laboratory</td>
<td>12, LAB, CI-M</td>
</tr>
<tr>
<td>One of the following three subjects:</td>
<td></td>
</tr>
</tbody>
</table>
| 3.016 Mathematical Methods for Materials Scientists and Engineers | 12; Calculus II (GIR)
| 18.03 Differential Equations | 12, REST; Calculus II (GIR) |
| 18.034 Differential Equations | 12, REST; Calculus II (GIR) |
| One of the following four subjects: | |
| 3.021J Introduction to Modeling and Simulation | 12, REST; 18.03* |
| 1.00 Introduction to Computers and Engineering Problem Solving | 12, REST; Calculus I (GIR) |
| 6.01 Introduction to EECS I | 12, 1/2 LAB; Physics II (GIR) |
| 3.016 Mathematical Methods for Materials Scientists and Engineers | 12; Calculus II (GIR) |
| 3.022 Microstructural Evolution in Materials | 12; 3.012 |
| 3.024 Electronic, Optical, and Magnetic Properties of Materials | 12; 3.012 |
| 3.032 Mechanical Behavior of Materials | 12; Physics I (GIR), 3.016* |
| 3.034 Organic and Biomaterials Chemistry | 12; 3.012 |
| 3.042 Materials Project Laboratory | 12; CI-M; 3.014* |
| 3.044 Materials Processing | 12; 3.012, 3.022 |
| **3.71U Thesis**, 9 (2) |  |
| or |  |
| 3.930 Industrial Practice | 6 |
| plus |  |
| 3.931 Industrial Practice | 6 |

<table>
<thead>
<tr>
<th>Restricted Electives</th>
<th><strong>48</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.016 Mathematical Methods for Materials Scientists and Engineers</td>
<td>12; Calculus II (GIR)</td>
</tr>
<tr>
<td>3.021J Introduction to Modeling and Simulation</td>
<td>12, REST; 18.03*</td>
</tr>
<tr>
<td>3.046 Thermodynamics of Materials</td>
<td>12, REST; 18.03*</td>
</tr>
<tr>
<td>3.048 Advanced Materials Processing</td>
<td>12; 3.022, 3.044</td>
</tr>
<tr>
<td>3.051J Materials for Biomedical Applications</td>
<td>12; Chemistry (GIR), Biology (GIR), 3.012*, 5.60*</td>
</tr>
<tr>
<td>3.052 Nanomechanics of Materials and Biomaterials</td>
<td>12; 3.012*</td>
</tr>
<tr>
<td>3.053J Molecular, Cellular, and Tissue Biomechanics</td>
<td>12; 18.03*, Biology (GIR), 2.370*</td>
</tr>
<tr>
<td>3.063 Polymer Physics</td>
<td>12; 3.012</td>
</tr>
<tr>
<td>3.066 Polymer Engineering</td>
<td>12; 3.032, 3.044</td>
</tr>
<tr>
<td>3.07 Introduction to Ceramics</td>
<td>12; 3.012</td>
</tr>
<tr>
<td>3.072 Symmetry, Structure, and Tensor Properties of Materials</td>
<td>12; 3.016*</td>
</tr>
<tr>
<td>3.073 Diffraction and Structure</td>
<td>12; 18.03, 3.024</td>
</tr>
<tr>
<td>3.074 Imaging of Materials</td>
<td>12; 3.024*</td>
</tr>
<tr>
<td>3.080 Economic and Environmental Materials Selection</td>
<td>12; 3.012*</td>
</tr>
<tr>
<td>3.04 Physical Metallurgy</td>
<td>12; 3.013, 3.022, 3.032</td>
</tr>
<tr>
<td>3.15 Electrical, Optical, and Magnetic Materials and Devices</td>
<td>12; 3.024</td>
</tr>
<tr>
<td>3.153 Nanoscale Materials</td>
<td>12; 3.024</td>
</tr>
<tr>
<td>3.155J Micro/Nano Processing Technology</td>
<td>12, CI-M; permission of instructor</td>
</tr>
</tbody>
</table>

### Departmental Program Units That Also Satisfy the GIRs | **(39)** |

### Unrestricted Electives | **48** |

### Total Units Beyond the GIRs Required for SB Degree | **185–195**

*No subject can be counted both as part of the 17-subject GIRs and as part of the 185–188 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.*

### Notes

* Alternate prerequisites are listed in the subject description.

(1) These subjects can count as part of the required subjects or as restricted electives, but not both.

(2) Students may elect 9–12 units.

(3) Substitution of similar subjects may be permitted by petition.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
### Bachelor of Science in Archaeology and Materials as Recommended by the Department of Materials Science and Engineering/Course 3-C

#### General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory Requirement (can be satisfied by 3.014 or 12.119 in the Departmental Program)</td>
<td>1</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement (can be satisfied by 3.012, 3.021j or 12.001 in the Departmental Program)</td>
<td>2</td>
</tr>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement (can be satisfied by 3.986, 3.987, 3.985j, and 21A.100; and 3.982, 3.983, or 3.988 in the Departmental Program)</td>
<td>8</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree: 17**

#### Communication Requirement

The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M).

#### PLUS Departmental Program

<table>
<thead>
<tr>
<th>Subject name below are followed by credit units, and by prerequisites, if any (corequisites in italics).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects</td>
</tr>
<tr>
<td>3.012 Fundamentals of Materials Science and Engineering, 15, REST; 18.03*</td>
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<tr>
<td>3.014 Materials Laboratory, 12, LAB, CI-M</td>
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<tr>
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<tr>
<td>One of the following three subjects:</td>
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<tr>
<td>3.021j Introduction to Modeling and Simulation, 12, REST; 18.03*</td>
</tr>
<tr>
<td>1.00 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)</td>
</tr>
<tr>
<td>6.01 Introduction to EECS I, 1, 1/2 LAB; Physics II (GIR)</td>
</tr>
<tr>
<td>3.022 Microstructural Evolution in Materials, 12; 3.012</td>
</tr>
<tr>
<td>3.034 Mechanical Behavior of Materials, 12; Physics I (GIR), 3.016*</td>
</tr>
<tr>
<td>or 3.044 Materials Processing, 12; 3.012, 3.022</td>
</tr>
<tr>
<td>3.07j Thesis, 9 (1)</td>
</tr>
<tr>
<td>3.985j Archaeological Science, 9, HASS; Chemistry (GIR)*</td>
</tr>
<tr>
<td>3.986 The Human Past: Introduction to Archaeology, 12, HASS-D</td>
</tr>
<tr>
<td>3.987 Human Origins and Evolution, 9, HASS</td>
</tr>
<tr>
<td>3.990 Seminar in Archaeological Method and Theory, 9, CI-M; 3.986, 3.985j, 21A.100</td>
</tr>
<tr>
<td>12.001 Introduction to Geology, 12, REST</td>
</tr>
<tr>
<td>12.110 Sedimentary Geology, 12; 12.001</td>
</tr>
<tr>
<td>or 12.119 Analytical Techniques for Studying Environmental and Geologic Samples, 12, LAB</td>
</tr>
<tr>
<td>21A.100 Introduction to Anthropology, 12, HASS-D</td>
</tr>
<tr>
<td>Restricted Electives(1)</td>
</tr>
<tr>
<td>One subject from the following list:</td>
</tr>
<tr>
<td>3.07 Introduction to Ceramics, 12; 3.012</td>
</tr>
<tr>
<td>3.14 Physical Metallurgy, 12; 3.012, 3.022, 3.032</td>
</tr>
<tr>
<td>3.02j Materials for Biomedical Applications, 12; Chemistry (GIR), Biology (GIR), 3.012*, 5.60*</td>
</tr>
<tr>
<td>3.032 Nanomechanics of Materials and Biomaterials, 12; 3.032*</td>
</tr>
<tr>
<td>One subject from the following list:</td>
</tr>
<tr>
<td>3.982 The Ancient Andean World, 9, HASS</td>
</tr>
<tr>
<td>3.983 Ancient Mesoamerican Civilization, 9, HASS</td>
</tr>
<tr>
<td>3.984 Materials in Ancient Societies: Metals, 12; permission of instructor</td>
</tr>
<tr>
<td>3.988 Africa—Past and Present, 9, HASS</td>
</tr>
</tbody>
</table>

#### Departmental Program Units That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>97</td>
</tr>
</tbody>
</table>

**Total Units Beyond the GIRs Required for SB Degree: 180–193**

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**Notes**

*Alternate prerequisites are listed in the subject description.

(1) Students may elect up to 9–12 units.

(2) Substitution of similar subjects may be permitted by petition.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
4.001] CityScope
(Same subject as 11.004J)
Prereq: None
U (Spring)
3-0-9 HASS

Project-based introduction to the contemporary city as a complex system within a context of limited resources and competing interests. Learn to assess scenarios for the purpose of formulating social, economic and design strategies that provide optimized solutions that are humane and sustainable. Group projects develop and advocate visions for housing, urban planning, regeneration of natural ecologies and other sectors of the city. Travel may be involved that will be funded, but not required. Includes exercises in written and oral communication and team building. Limited to 15 participants. Preference to freshmen.

J. Fernandez, P. Thompson

4.102 Drawing for Architects
Prereq: 4.111
U (IAP)
0-3-0 [P/D/F]

Focuses on drawing as a translation from three-dimensional form and space to two-dimensional representation. Expands critical and organizational skills for seeing and drawing. Explores a full range of drawing techniques, materials, and image-making strategies. Fortifies the use of drawing in the architecture studio practice, through a multidisciplinary understanding of freehand drawing, in the context of both art and architecture. Limited to first year MArch students.

Architecture Design Staff

4.105 Geometric Disciplines and Architecture Skills I
Prereq: Permission of instructor
G (Fall)
2-2-5

4.106 Geometric Disciplines and Architecture Skills II
Prereq: 4.105
G (Spring)
2-2-5

Introduction to the architectural design process and its tools. Develops skills ranging from techniques of hand drafting, to generation of 3-D computer models, physical model-building, sketching, and diagramming. The conceptual and technical basis of each exercise has a reciprocal relationship with studio and the instruments necessary to approach studio design problems. Lectures address the conventions associated with modes of architectural representation and their capacity to convey ideas. Pin-ups teach legible presentation of architectural concepts through fabricated images and presentation manner. Restricted to level one MArch students.

J. Lamere

4.108 BSAD Portfolio Workshop
Prereq: 4.113
U (Fall)
2-0-1

Covers the skills needed to design a successful portfolio that can be used to apply for internships and graduate study. Topics include design aesthetics, graphics, book assemblage, binding techniques, and various computer applications. Limited to Course 4 majors and minors.

R. Luther

4.111 Experiencing Architecture Studio
Prereq: None
U (Fall, Spring)
3-3-6

Uses drawings, scale models, and computer simulations to design environments that orchestrate contrasting material properties to create places that foster specific ways of inhabiting space. Gives an experience of designing as a mode of creative thought. Intended for students who wish to test their aptitude for architectural design. Conducted in a studio format, with lectures on architectural theory and history. Structured for students with no previous experience in design.

B. Hubbard

4.112 Integrated Architecture Design Studio
Prereq: 4.111
U (Fall)
3-3-6

Credit cannot also be received for 4.12A

Second undergraduate design studio. Design within the context of structures, building technology, visual arts, computation and architectural history through several short design projects. Develop and present design solutions through the use of models, drawings, sketching and 3-D computer modeling. Studio format with a combination of lectures and guided work.

A. Watson

4.113 Applied Architecture Design Studio I
Prereq: 4.112 or 4.12A
U (Spring)
3-6-6

Third undergraduate design studio. Offers several small-scale studio problems that build on the development of space, scale, structure, light, site and program. Introduces several architectural ideas and issues through drawing exercises, models, analysis of precedents, and explored design methods. Skills developed in conceptualizing, articulating, and representing architectural ideas and making aesthetic judgments about building design. Preference to Course 4 majors and minors.

N. Correa-Mehrotra

4.114 Applied Architecture Design Studio II
Prereq: 4.113, 4.302, 4.401, 4.500, 4.605
U (Fall)
0-12-9

Fourth undergraduate design studio focuses on how to build appropriately in a natural or urban site through analysis of landscape and climate. Students conceptualize design decisions through drawings and models. Four design projects, including a complex and extensive final
project, are assigned. Teamwork emphasized with one major project focusing on team design. Instruction and practice in oral and written communication provided. Preference to Course 4 majors and minors. Mandatory lottery. 

J. Wampler, Architecture Design Staff

4.115 Applied Architecture Design Studio III
Prereq: 4.114
U (Spring)
0-12-9
Fifth undergraduate design studio. Introduces skills needed to build within contemporary cities, extending from the historical center to expanding edges. Analyze an existing environment and design a built structure that fosters relationships between its intended activities and the larger urban territory and redefines the urban environment. Design project emphasizes issues of housing. Preference to Course 4 majors. Mandatory lottery. 

Architectural Design Staff

4.116 Advanced Architecture Design Studio
Prereq: 4.115, 4.440
U (Fall, Spring)
0-12-9
Sixth undergraduate design studio. Projects develop the design skills and the experience of both theoretical and pragmatic issues facing the architect. Focus on how architecture creates environments for living, working, and learning in varied settings and with complex programmatic needs in an international setting. Integrates environmental and climatic concerns, structure and constructional parameters. Preference to Course 4 majors. Mandatory lottery. 

J. M. Yoon

4.119 Preparation for Undergraduate Architecture Design Thesis
Prereq: 4.115
U (Fall, Spring)
1-0-2
Selection of thesis topic, defining method of approach, and preparation of thesis proposal for BSAD degree in architecture design. Weekly class meeting as well as individual conference with faculty. 

Architecture Design Staff

4.121 Workshop in Making and Designing Space (New)
(Subject meets with 4.122)
Prereq: 4.123 or permission of instructor
G (Spring)
0-6-3
4.122 Workshop in Making and Designing Space
(Subject meets with 4.121)
Prereq: 4.111
U (Spring)
0-6-3
Interactive architecture design workshop focuses on the logistics of designing. Examines a variety of spaces and studies space design through material exploration and building techniques. Students develop a design project by joining wood, forging and welding steel, and casting concrete. Additional work required of students taking the graduate version. 

C. Dewart, J. Wampler

4.123, 4.124 Architectural Design: Level I
Prereq: Permission of instructor
G (Fall, Spring)
0-12-9
Can be repeated for credit
Establishes basic attitudes toward architectural organization and its reflection in form. Includes projects where imposed conditions of site, program, and building system emphasize the interrelationship of fundamental elements in the pattern of decision making that constitutes architectural design. Develops presentations through drawings and models. Intended for entering MArch students. Must be taken in sequence. 

Architectural Design Staff

4.12A Integrated Architecture Design Intensive Studio
Prereq: 4.111
U (IAP)
3-3-3
Can be repeated for credit
Second undergraduate design studio. Design within the context of structures, building technology, visual arts, computation and architectural history through several short design projects. Develop and present design solutions through the use of models, drawings, sketching and 3-D computer modeling. Studio format with a combination of lectures and guided work. 

A. Watson

4.143 Architectural Design: Level II
Prereq: 4.124
G (Fall)
0-12-9 H-LEVEL Grad Credit
Can be repeated for credit
Students complete projects to develop the design skills and experience of both theoretical and pragmatic issues facing the architect. Focuses on the material and tectonic aspects of architectural production, especially as they influence the generative ideas of form. Integrates urbanistic, environmental and climatic concerns, structure, and constructional parameters. Mandatory lottery process. 

Architectural Design Staff

4.144 Architectural Design: Level II
(Subject meets with 4.156)
Prereq: 4.143
G (Spring)
0-10-11 H-LEVEL Grad Credit
Can be repeated for credit
4.155 Architectural Design: Level III
Prereq: 4.144
G (Fall)
0-10-11 H-LEVEL Grad Credit
Can be repeated for credit
4.156 Architectural Design: Level III
(Subject meets with 4.144)
Prereq: 4.155
G (Spring)
0-10-11 H-LEVEL Grad Credit
Can be repeated for credit
Emphasizes setting of architectural work as part of an organized community in projects having to do with built-up areas, as well as those on new sites. Studies plan for long-range development, giving students increasing experience in the analysis of real-life situations requiring program research. Mandatory lottery process. 

Architectural Design Staff

4.163 Urban Design Studio
(Same subject as 11.332J)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
The design of urban environments. Strategies for change in large areas of cities, to be developed over time, involving different actors. Fitting forms into natural, man-made, historical, and cultural contexts; enabling desirable activity patterns; conceptualizing built form; providing infrastructure and service systems; guiding the sensory character of development. Involves architecture and planning students in joint work;
requires individual designs or design and planning guidelines.
A. Berger, M. Dennis, A. D’Hooghe, R. Mehrotra

4.166 Beijing Urban Design Studio
(Subject meets with 11.307)
Prereq: 4.144
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Design and development studio that involves architects and planners, working in teams on a contemporary design project of importance in Beijing, China. Students analyze conditions, explore alternatives, and synthesize architecture, city design, and implementation plans. Supplemented by lectures and brief study tours that expose students to history and contemporary issues of urbanism in China. Offered every other summer in residence at Tsinghua University, Beijing, involving students and faculty from both schools. Limited to 10.
J. Wampler, D. Frenchman

4.170 International Architecture Design Workshop
Prereq: Permission of instructor
U (Fall, Spring)
3-2-7
Can be repeated for credit

Interactive design research in developing areas outside of the USA. Assist in drawing, modeling, and constructing small buildings appropriate for the culture, climate and specific population under consideration.
J. Wampler

4.171 Design Workshop: The Space Between
Prereq: Permission of instructor
G (Fall, Spring)
3-2-4 H-LEVEL Grad Credit
Can be repeated for credit

Design research into the space between and the space within buildings and cities. Projects include the development and understanding of existing space in buildings and cities, as well as designing new structures looking at the space first and the object second.
J. Wampler

4.175 Case Studies in City Form
Prereq: Permission of instructor
G (Fall)
0-6-6 H-LEVEL Grad Credit

Introduction to urban form and design, focusing on the physical, historical, and social form of cities. Selected cities are analyzed, drawn, and compared, to develop a working understanding of urban and architectural form. The development of mapmaking and urban representation is discussed, and use of the computer is required. Special focus on the historical development of the selected cities, especially mid-19th and mid-20th century periods of expansion. Readings on urban design theory in the 20th century and a weekly discussion/seminar on them. Methods class for SMArchS students in Architecture and Urbanism.
M. Dennis

4.180 Architectural Design Workshop
Prereq: 4.113 or permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit

4.181–4.185 Architectural Design Workshops
Prereq: 4.115, 4.143 or permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Subject in design inquiry taught in studio format treating selected issues of the built world in depth. The problem may be prototypical or a particular aspect of a whole project, but always interdisciplinary in nature.
Architectural Design Staff

4.189 Preparation for MArch Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
3-1-5 H-LEVEL Grad Credit
Can be repeated for credit

Preparatory work and research leading to a well-conceived proposition for the MArch design thesis. Students formulate a cohesive thesis argument and project using supportive research and case studies through a variety of representational media, critical traditions, and architectural/artistic conventions. Group study in seminar and studio format, with periodic reviews supplemented by conference with faculty and a designated committee member for each individual thesis. Restricted to MArch students.
N. Tehrani

4.190 Practical Experience in Architecture
Prereq: Permission of instructor
G (Fall)
0-0-3 [P/D/F]

Practical experience through summer internships secured by the student in the field of architecture, urbanism, digital design, art, or building technology.
Staff

4.191, 4.192 Special Problems in Architectural Design
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit

4.194 Special Problems in Architectural Design
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

4.195, 4.196 Special Problems in Architectural Design
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Architectural Design Staff

4.205 Analysis of Contemporary Architecture
Prereq: None
U (Fall)
3-0-9 HASS

Explores pivotal events and buildings that have shaped today’s understanding and approach to contemporary architecture. Emphasis placed on buildings and works of individual architects, as given from a practicing architect’s perspective. Site visits used to help evaluate a building’s significance or lack thereof. Students analyze these buildings through drawing, modeling, reading, and writing. Provides a general framework in which to understand contemporary architectural design and to build a visual vocabulary to help communicate more effectively about design.
D. Chen

4.210 Precedents in Critical Practice (New)
Prereq: None
G (Fall)
3-0-6

Seminar maps contemporary architectural practice and develops tools for scrutinizing that map through formal readings on current architectural thinking, popular culture, and politics. Examines attempts at the current architectural discourse and theories published in Hunch, Log, the last issue of Assemblage, and in Harvard Design Magazine. Students read about and analyze buildings and building projects within the con-
text of their discipline and culture. Restricted to level I MArch students.
A. Miljacki

4.211J The Once and Future City
(Same subject as 11.016J)
Prereq: None
U (Spring)
3-0-9 HASS, CI-H
See description under subject 11.016J.
A. Spirn

(Same subject as 11.308J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.308J.
A. Spirn

4.214J Water, Landscape and Urban Design (New)
(Same subject as 11.314J)
Prereq: Permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit
Can be repeated for credit
Workshop surveys how water affects the design of buildings, landscapes and cities in aesthetic, functional and symbolic ways. Combines the systematic study of water issues with urban design projects in South Asia and the US. Covers topics such as rainwater harvesting, water use efficiency, wastewater reuse, stormwater management, floodplain design, constructed wetlands, and waterfront development. Students work together to integrate these design concepts at the site, urban, and international scales. Limited to 15.
J. Wescoat

4.215J Sensing Place: Photographing the Urban Landscape
(Same subject as 11.309J)
Prereq: None
G (Fall)
3-0-9
See description under subject 11.309J.
A. Spirn

4.216J Landscape and Urban Heritage Conservation (New)
(Same subject as 11.316J)
Prereq: Permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit
Can be repeated for credit
Workshop focuses on cultural landscape heritage issues and projects in the Indo-Islamic realm. Landscape and urban heritage inquiry goes beyond monuments and combines study of conservation theory and practice with exploration of active urban environmental design projects. Limited to 15.
J. Wescoat

4.218, 4.219 Special Problems in Urban Housing
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
M. Dennis, A. D’Hooghe, R. Goethert

Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit
M. Dennis

4.221 Architecture Studies Faculty Colloquium
Prereq: Permission of instructor
G (Fall)
2-0-1
Presentations by faculty from different discipline groups on a theme derived from their research or practice followed by discussion. Requirements include active student participation and a final paper or presentation reviewing the theoretical issues raised by the colloquium discussions in the context of the research themes set by the instructors.
J. Beinart, R. Mehrotra

4.222 Professional Practice
Prereq: Permission of instructor
G (Fall)
3-0-3 H-LEVEL Grad Credit
Gives a critical orientation toward a career in architectural practice. Uses historical and current examples to illustrate the legal and ethical concepts underlying present practice, and from them, to trace the possible trajectories of future practice.
P. Freelon

4.224 Advanced Research in Contemporary Architecture (New)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Seminar to research the contemporary conditions of producing architecture, the contemporary role of the architect, and the contemporary production of architectural discourse. Embraces “operative criticism” as the key mode of generating knowledge and clarifying positions. Surveys the role of operative criticism within the discipline, and how it takes the contemporary production of architecture as its subject and advocates for particular outcomes. Limited to 18.
A. Miljacki

4.230J SIGUS Workshop
(Same subject as 11.468J)
(Subject meets with 4.231)
Prereq: Permission of instructor
G (IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
4.231 SIGUS Workshop (New)
(Subject meets with 4.230J, 11.468J)
Prereq: Permission of instructor
U (IAP, Spring)
Units arranged
Can be repeated for credit
Interdisciplinary projects and interactive practices in urban settlement issues as investigated by MIT’s SIGUS (Special Interest Group in Urban Settlements), with a focus on developing countries throughout the world. Participation by guest practitioners. Additional work required of students taking the graduate version.
R. Goethert
(Same subject as 11.444J)
(Subject meets with 4.233)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

4.233) The New Global Planning Practitioner (New)
(Subject meets with 4.232J, 11.444J)
Prereq: Permission of instructor
U (Spring)
3-0-6

Considers a new interdisciplinary paradigm of practice that regards dialogue among practitioners and users essential for efficacious and creative design and planning process. Focuses on non-traditional client groups: communities, the poor, and the generally excluded middle-income. Explores key issues confronting development practitioners, with emphasis on practical exercises drawn from current national and international case studies; e.g., an investigative comparison of the ways Bangkok vs Singapore cope with impending rapid and massive growth and expansion. Engages those with a design and community service orientation. Additional work required of students taking the graduate version.

R. Goethert

4.236) Structuring Low-Income Housing Projects in Developing Countries
(Same subject as 11.463J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Examines dynamic relationship among key actors: beneficiaries, government, and funder. Emphasis on cost recovery, affordability, replicability, user selection, and project administration. Extensive case examples provide basis for comparisons.

R. Goethert

4.241) Theory of City Form
(Same subject as 11.330J)
Prereq: 11.001J, 4.252J, or 11.301J
G (Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Theories about the form that settlements should take. Attempts a distinction between descriptive and normative theory by examining examples of various theories of city form over time. Concentrates on the origins of the modern city and theories about its emerging form, including the transformation of the 19th-century city and its organization. Analyzes current issues of city form in relation to city-making, social structure, and physical design.

J. Beinart

4.242) Advanced Seminar in City Form
(Same subject as 11.331J)
Prereq: 4.241J or 11.330J
G (Fall)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Examines in greater depth themes from the basic subject in city form theory. Introduces new concepts from current research and practice for analysis by the seminar participants. Requirements include presentation to the seminar of a theoretical project undertaken by each student.

J. Beinart

4.244) Urban Design Seminar
(Same subject as 11.333J)
Prereq: None
G (Spring)
2-0-7

See description under subject 11.333J.

D. Frenchman

4.247) Urban Design Policy and Action
(Same subject as 11.337J)
Prereq: 11.301J
G (Spring)
2-0-7 H-LEVEL Grad Credit

See description under subject 11.337J.

A. Inam

4.248, 4.249 Special Problems in City Form
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.

J. Beinart, M. Dennis, A. D’Hooghe

4.250) Introduction to Urban Design and Development
(Same subject as 11.001J)
Prereq: None
U (Spring)
3-0-9 HASS

See description under subject 11.001J.

S. Silberberg-Robinson

4.252) Introduction to Urban Design and Development
(Same subject as 11.301J)
Prereq: Permission of instructor
G (Fall)
3-0-9

See description under subject 11.301J.

D. Frenchman

4.253) Urban Design Politics
(Same subject as 11.302J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject 11.302J.

L. Vale

4.254) Real Estate Development Studio: Complex Urban Projects
(Same subject as 11.303J)
Prereq: Permission of instructor
G (Spring)
6-0-9 H-LEVEL Grad Credit

See description under subject 11.303J.

D. Frenchman, P. Roth
4.255) Site and Urban Systems Planning
(Same subject as 11.304J)
Prereq: Permission of instructor
G (Spring)
2-2-8
See description under subject 11.304J.
E. Ben-Joseph

4.257) Property Rights in Transition
(Same subject as 11.467J, 17.550J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.467J.

4.259) Special Problems in Urban Design
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
J. Beinart, M. Dennis, A. D’Hooghe

(Same subject as 11.336J)
Prereq: None
G (Spring)
3-0-9
Seminar examines the advent of modernism in Asia and its emergent manifestations in architecture and urbanism. Theoretical writings, built work and case studies of architectural practices in the region serve as the basis for examining and understanding the contemporary architectural and urban landscapes of Asia. Critical discussion of themes such as notions of modernity, critical regionalism, vernacularism, tropicalism, counter-modernity, nationalism, and issues of architectural identity. Also covers issues related to emergent urban landscapes in Asia, including informal urbanism and sustainability, and addresses questions about historic preservation.
R. Mehrrota

4.262) Ideal Forms of Contemporary Urbanism
(Same subject as 11.311J)
Prereq: 4.645, 4.241J, 11.330J or permission of instructor
G (Fall)
Units arranged H-LEVEL Grad Credit
Advanced seminar about an architectural approach to the problems of disurbanization.

4.264) Advanced Seminar in Landscape & Urbanism (New)
(Same subject as 11.334J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.334J.
A. Berger

4.278) Special Problems in Theory in Architecture
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
J. Wescoat

4.280) Undergraduate Architecture Internship
Prereq: 4.114
U (IAP)
0-0-6 [P/D/F]
Can be repeated for credit
Work in an architect’s office to gain experience, improve skills, and see the inner workings of an everyday architectural practice. Internships in all sizes of firms and in public and nonprofit agencies. Internships require full-time work for the entire IAP.
N. Correa Mehrotra

4.287) Graduate Architecture Internship
Prereq: 4.123
G (IAP)
0-0-6 [P/D/F]
Can be repeated for credit
Work in an architect’s office to gain experience, improve skills, and see the inner workings of an everyday architectural practice. Internships in all sizes of firms and in public and nonprofit agencies. Internships require full-time work for the entire IAP.
N. Correa Mehrotra

4.288) Preparation for SMArchS Thesis
Prereq: 4.290
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Students select thesis topic, define method of approach, and prepare thesis proposal for SMArchS degree. Faculty supervision on an individual or group basis. Intended for SMArchS program students prior to registration for 4.ThG.
Staff

4.290) SMArchS Pre-Thesis Preparation
Prereq: 4.221 or permission of instructor
G (Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Preliminary work in preparation for the thesis for the SMArchS degree. Supervised by faculty on an individual or group basis. Intended for second term SMArchS program students prior to registration for subject 4.288.
Staff

4.285, 4.286) Research Topics in Architecture Studies
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Individual or group research. Registration subject to prior arrangement for subject matter and supervision by staff.
J. Wescoat
4.291 Special Problems in Architecture Studies  
Prereq: Permission of instructor  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit

4.292, 4.293 Special Problems in Architecture Studies  
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit

4.294 Special Problems in Architecture Studies  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit

4.295–4.297 Special Problems in Architecture Studies  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit

4.298–4.299 Special Problems in Architecture Studies  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit

Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.  
C. Ulmann

4.301 Introduction to Visual Arts  
Prereq: None  
U (Fall, Spring)  
2-4-6 HASS-D, Category 3  
Credit cannot also be received for 4.302

Introduction to contemporary artistic practice and aesthetic analysis through studio work and lectures based on current themes. Students communicate ideas and experiences through a range of media such as sculpture, installation, performance, and video. Projects evolve through stages of conceptual and material development to final presentation. Lectures, screenings, visiting artist presentations, field trips, and readings supplement studio practice and provide insight into the historical, cultural, and environmental forces that affect both development of artistic vision and reception of works of art. Lab fee.  
Fall: W. Jacob  
Spring: G. Urbonas

4.302 Foundations in the Visual Arts for Majors  
Prereq: None  
U (Spring)  
2-4-6  
Credit cannot also be received for 4.301

Offers a foundation in the audio-visual art practice and its critical analysis for beginning architecture students. Emphasis on long-range artistic development and its analogies to architectural thinking and practice. Teaches students to communicate ideas and experiences through various two-dimensional, three-dimensional, and time-based media, including sculpture, installation, performance, and video screening. Lectures, visiting artist presentations, field trips, and readings supplement studio practice. Instruction and practice in written and oral communication provided. Restricted to Course 4 majors. Lab fee.  
W. Jacob

4.303 Art, Architecture, and Urbanism in Dialogue  
Prereq: None  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Fall)  
3-3-3

Engages dialogue between architecture, urbanism and contemporary art from the perspective of the artistic field. Thematically investigates ideas from early modernist practices to recent examples of contemporary production and site. Examples of artistic practice along with architectural and urban approaches. Focuses on interventions by practitioners who intertwine the three disciplines. Readings provide theoretical background. Lectures, screenings, readings and discussions with guests and faculty lead to the development and realization of group and individual projects for final presentations. Lab fee.  
Visual Arts Staff

4.310 Contemporary Curatorial Practice (New)  
Prereq: permission of instructor  
G (Spring)  
3-3-6 H-LEVEL Grad Credit

Addresses curatorial practice as an activity that intertwines theory and practice, and reflects the socio-political context of artistic and cultural production. Studies and discusses the role of the curator and the impact of site: local, global, dislocation and display. Examines 20th- and 21st-century exhibitions, exploring the exhibition as dispositif. Presents the range of institutions and variety of exhibition formats representing art and culture. Individual and collective exhibition concepts are explored and developed.  
U. M. Bauer

4.312 Advanced Studio on the Production of Space (New)  
(Subject meets with 4.313)  
Prereq: 4.301, 4.302 or permission of instructor  
U (Fall)  
3-3-6  
Can be repeated for credit

4.313 Advanced Studio on the Production of Space (New)  
(Subject meets with 4.312)  
Prereq: Permission of instructor  
G (Fall)  
3-3-6 H-LEVEL Grad Credit  
Can be repeated for credit

Introduces spatial concepts for different times and cultures and examines how they relate to artistic process and production. Explores relational qualities of spatial concepts and reflects on their producers and proponents. Investigates the notion of utopian, dystopian and heterotopian space, inner and outer space, the void, the vacuum, the in-between, and the ‘real’ versus ‘virtual’ space from the perspective of production. Guest speakers from various disciplines, readings and in-class presentations support the development of individual and collective projects. Additional work required of students taking the graduate version. Enrollment limited.  
G. Urbonas

4.314 Advanced Workshop in Artistic Practice and Transdisciplinary Research (New)  
(Subject meets with 4.315)  
Prereq: 4.301, 4.302 or permission of instructor  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit

4.315 Advanced Workshop in Artistic Practice and Transdisciplinary Research (New)  
(Subject meets with 4.314)  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit

Examines contemporary art as a form of investigation and knowledge production. Evaluates models of experimentation, individual research, and collaboration with other disciplines in arts, culture, science and technology. Supports the development and supervision of individual and collective artistic research projects between students, research scientists and faculty from varying fields. Additional work required of students taking the graduate version. Enrollment limited.  
U. M. Bauer
4.322 Introduction to Three-Dimensional Art Work
Prereq: None
U (Spring)
2-4-6 HASS

Fundamental issues in three-dimensional art work such as sculpture and installations. Addresses site, context, process, fabrication, and an object’s relation to the body. Lectures, screenings and field trips supplement studio practice. Lab fee. Enrollment limited.

Visual Arts Staff

4.330 Introduction to Networked Cultures and Participatory Media (New)
(Subject meets with 4.331)
Prereq: None
U (Fall)
3-3-6 HASS, CI-H

4.331 Introduction to Networked Cultures and Participatory Media (New)
(Subject meets with 4.330)
Prereq: None
G (Fall)
3-3-6

Overview of “art for all” and participatory art practices, early net-art, net-activism, and current online practices in art and culture. Explores cultural and political impacts of mediated communication. Examines how online communications have altered the way in which collaboration occurs, changes notions of authorship, and gives rise to the collective. Students implement, critique, and discuss design exercises and experiments. Additional work required of students taking the graduate version.

A. Frid-Jimenez

4.332 Advanced Seminar in Networked Cultures and Participatory Media (New)
(Subject meets with 4.333)
Prereq: 4.330 or permission of instructor
U (Spring)
3-3-6

4.333 Advanced Seminar in Networked Cultures and Participatory Media (New)
(Subject meets with 4.332)
Prereq: 4.330, 4.331 or permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit

Teaches skills to create networked platforms and participatory media such as hybrid TV. Explores the development of new critical media platforms and strategies. Students implement, critique, and discuss design exercises and experiments. Additional work required of students taking the graduate version.

Visual Arts Staff

4.341 Introduction to Photography and Related Media
Prereq: None
U (Fall, Spring)
3-3-6 HASS

Combines hands-on experience, lectures, visiting professionals, group discussions, readings, and field trips. Fosters aesthetic appreciation of photography/digital imaging as well as a critical awareness of how images in our culture are produced and constructed. Practical instruction in camera formats, film exposure and development, black and white darkroom printing, digital imaging, and studio lighting. Assignment designed to develop technical skills and provide opportunity for personal exploration. Projects continuously presented and discussed in a critical forum. Lab fee. Limited enrollment.

A. Frank

4.343 Photography and Related Media
Prereq: Permission of instructor
G (Fall, Spring)
3-1-5
Can be repeated for credit

Practical instruction, readings, lectures, field trips, visiting artists, group discussions, and individual reviews. Fosters a critical awareness of how images in our culture are produced and constructed. Student-initiated term project at the core of exploration. Special consideration given to the relationship of the photographic image to context and space. Practical instruction in the fundamentals of different camera formats, film exposure and development, black and white darkroom printing, digital imaging, and studio lighting. Open to beginning and advanced students. Lab fee. Enrollment limited; preference to current MArch students.

A. Frank

4.351 Introduction to Video
Prereq: None
U (Spring)
2-4-6 HASS

Introduction to video recording and editing, presenting video as a tool of personal apprehension and expression. Emphasis on exploration reflecting identity, performance, social critique, and the organization of raw experience into aesthetic form (narrative, abstract, documentary, essay). Lab fee. Limited to 12.

J. Jonas

4.352 Advanced Video
(Subject meets with 4.353)
Prereq: 4.351 or permission of instructor
U (Fall)
2-4-6 HASS

4.353 Advanced Video
(Subject meets with 4.352)
Prereq: Permission of instructor
G (Fall)

Units arranged H-LEVEL Grad Credit

Introduction to advanced strategies of image/sound manipulation, both technical and conceptual. Pre-production planning (storyboards, scripting), refinement of digital editing techniques, visual effects such as chroma-keying, and post-production and audio are covered. Context provided by regular viewings of contemporary video artworks and other audio-visual formats. Additional work required of those taking the graduate version. Lab fee. Enrollment in each subject limited to 12.

Visual Arts Staff

4.360 Performance Workshop
Prereq: Permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit
Can be repeated for credit

Performance is considered in relation to the media and to spatial structures imagined as settings for narrative movements. Students are asked to consider particular subjects or narratives to work with as source material for experiments in the transforming of an idea into visual form. Video functions as a basic tool while questions of perception in relation to sound and image and how they are altered by various devices are explored. Students make props or objects that embody aspects of their narratives to use in relation to movement and space. Assignments during the workshops lead to a final performance project. Lab fee.

J. Jonas

4.365 Advanced Projects in Visual Arts
Prereq: permission of instructor
G (Fall, Spring)

Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Investigates conceptual and formal issues in different media or between media such as sculpture, photography and video. Explores issues of representation, interpretation and meaning, and how they relate to historical, social and cultural context.

J. R. Lee
4.366 Advanced Projects in Visual Arts
Prereq: Permission of instructor
U (Fall, Spring)
2-4-6 HASS
Can be repeated for credit
Investigates conceptual and formal issues in different media or between media such as sculpture, photography, and video. Explores issues of representation, interpretation, and meaning, and how they relate to historical, social, and cultural context.
W. Jacob

4.367 Studio Seminar in Public Art
(Subject meets with 4.368)
Prereq: Permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit
4.368 Studio Seminar in Public Art
(Subject meets with 4.367)
Prereq: Permission of instructor
U (Spring)
3-3-6 HASS
Focuses on the production of visual art in public places, outside the gallery/museum context. Students are expected to develop a project throughout the term for public placement during finals. Aesthetic, social, and political issues in the urban setting are to be analyzed vis-à-vis enforced public policy. Traditional forms of commemoration examined, in comparison to more temporal and critical forms of public art and action. Historical models include the Russian Constructivists, the Situationists International, Conceptual Art, and more recent interventionist tactics. Readings assigned to help assess the understanding, meaning and intention of each individual’s project. Additional work required of students taking the graduate version.
A. Muntadas

4.370 Interrogative Design Workshop
(Subject meets with 4.371)
Prereq: Permission of instructor
G (Fall, Spring)
3-3-6 H-LEVEL Grad Credit
Can be repeated for credit
4.371 Interrogative Design Workshop
(Subject meets with 4.370)
Prereq: Permission of instructor
U (Fall, Spring)
3-3-6 HASS
Can be repeated for credit
Addresses design media and technology as both ethical and aesthetic practice. Development of projects finalized as working tools, instruments, implements, and equipment is supported by relevant theoretical study, presentations and informed discussion. Workshop poses new questions, exposes hidden issues, and creates inspirational and experimental situations for designers and artists as cultural agents. Additional work required of students taking the graduate version.
K. Wodiczko

4.381 Advanced Visual Design
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Individual concepts, projects, design, and execution of installations, objects, and events in environmental art and performance involving elemental and science-technology means and media.
A. Frid-Jimenez

4.388 Preparation for SMVisS Thesis
Prereq: Permission of instructor
G (Spring, Summer)
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit
Visual Arts Staff

4.389 Tutorial for SMVisS Thesis
Prereq: 4.388
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit
Weekly presentations, group meetings and critique by thesis class. Supports independent thesis research by providing methodology and focus supplemented by regular individual conference with thesis committee members. Prerequisite for 4.390.
Visual Arts Staff

4.390 Visual Arts Independent Studio
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Addresses inquiry and debate about art, culture and society in relation to independent art projects by SMVisS students. Regular presentations to visual arts faculty and guest critics. Students develop skills in how to organize their portfolios, formulate grant applications, and successfully explain and promote their work. Includes regular consultations with faculty and thesis advisors.

4.391–4.393 Special Problems in Visual Arts
Prereq: 4.301
Units arranged
Can be repeated for credit
4.394 Special Problems in Visual Arts
Prereq: Permission of instructor
Units arranged
Can be repeated for credit
4.395–4.397 Special Problems in Visual Arts
Prereq: Permission of instructor
Units arranged
Can be repeated for credit
4.398, 4.399 Special Problems in Visual Arts
Prereq: Permission of instructor
Units arranged
Can be repeated for credit
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Visual Arts Staff

4.401 Introduction to Building Technology
Prereq: None
U (Spring)
3-2-7
Introduction to the physical process behind the design of a building’s envelope, interior, and equipment. Integration of technological constraints in architectural design: Response to climate, construction methods and issues, heat and air flow, thermal comfort and insulation, passive and active heating and cooling, natural and electric lighting, visual comfort, acoustics.
M. Andersen

4.406 Ecologies of Construction
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Examines the material and energy networks currently utilized to transfer resources from the natural world to the built environment. Theories and tools of industrial ecology are used to reveal opportunities for creating ecologies of construction; that is, mutually beneficial relationships between distinct components of the industry of construction that may be made to act symbiotically. Both the production and consumption of the architectural artifact is reviewed using tools of analysis that physically account for the flow
of materials into and out of various spatial and temporal scales and boundaries.

J. Fernandez

4.408 Special Problems in Building Construction
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.

Building Technology Staff

4.411 Building Technology Laboratory
Prereq: Physics II (GIR), Calculus II (GIR)
U (Fall)
2-4-6 Institute LAB
Concepts of building technology and experimental methods. Projects vary yearly and have included design and test of strategies for daylighting, passive heating and cooling, and improved indoor air quality via natural ventilation. Experimental methods focus on measurement and analysis of thermally driven and wind-driven airflows, lighting intensity and glare, and heat flow and thermal storage. Experiments are conducted at model scale and are compared with simulation. Motivated by ongoing fieldwork in developing countries.

L. K. Norford

4.421 Fundamentals of Energy in Buildings
(Same subject as 1.044J, 2.66J)
Prereq: Physics I (GIR), Calculus II (GIR)
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-2-7 REST

L. R. Glicksman

4.423J Architectural Thermal and Fluid Dynamics
(Same subject as 2.661J)
Prereq: 2.005, 4.42, or 2.25
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-2-7 H-LEVEL Grad Credit

L. Glicksman, L. K. Norford

4.427J Analysis and Design of Heating, Ventilating, and Air Conditioning Systems
(Same subject as 2.67J)
Prereq: 2.006 or 4.42
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Explores the fundamentals of heating, ventilating, and air-conditioning (HVAC) systems. Topics include discussion of psychrometrics, air conditioning processes, thermal comfort, indoor air quality and outdoor design conditions. Emphasis on the calculation of heating and cooling load in order to size suitable HVAC equipment, estimate energy consumption of the HVAC equipment, and control HVAC equipment. Both manual and computer methods are used. One or more site visits.

L. K. Norford, L. Glicksman

4.428, 4.429 Special Problems in Energy in Buildings
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.

L. R. Glicksman, L. K. Norford

4.430 Daylighting
Prereq: 4.401 or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Provides the tools necessary for an efficient integration of daylighting issues in the overall design of a building. Fundamentals of daylighting and electric lighting are introduced and their relevance to design decisions emphasized: benefits and availability of daylight, solar radiation and sun course, photometry, vision and color perception, daylighting metrics, visual and thermal comfort, electric lighting. More advanced topics are presented and practiced through the design project and homework assignments, such as primary and advanced lighting design strategies, and design and assessment tools for lighting management.

M. Andersen

4.431 Architectural Acoustics
Prereq: 4.401
G (Spring)
Units arranged H-LEVEL Grad Credit
Describes interactions between people and sound, indoors and outdoors, and uses this information to develop acoustical design criteria for architecture and planning. Principles of sound generation, propagation, and reception. Properties of materials for sound absorption, reflection, and transmission. Design implications for performance and gathering spaces. Use of computer modeling techniques.

C. J. Rosenberg

4.438 Special Problems in Architectural Lighting
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.

M. Andersen

4.440 Building Structural Systems I
(Subject meets with 4.462)
Prereq: Calculus II (GIR)
U (Spring)
3-3-6 REST
Introduces the design and behavior of large-scale structures and structural materials. Emphasizes the development of structural form and the principles of structural design. Introduces design methods for timber, masonry, concrete, and steel applied to long-span roof systems, bridges, and high-rise buildings. Includes environmental assessment of structural systems and materials. Laboratory to solve structural problems by building and testing simple models. Graduate and undergraduate students have separate lab sections.

L. K. Norford

4.444 Analysis of Historic Structures
(Subject meets with 4.445)
Prereq: None
U (Spring)
3-0-9
Technical and historical study of structures in architecture and engineering. Focuses on the design and assessment of historic structures in masonry, timber, concrete, and metal. Course is
driven by student research proposals. Previous student projects have researched Gothic flying buttresses, wooden covered bridges, Roman aqueducts, and iron train stations.

J. Ochsendorf

4.445 Analysis of Historic Structures
(Subject meets with 4.444)
Prereq: None
G (Spring)
3-0-6
Technical and historical studies of structures in architecture and engineering. Focuses on the design and assessment of historic structures in masonry, timber, concrete, and metal. Assignments include problem sets and presentations, with a major focus on a final research paper. Previous student projects have researched Gothic flying buttresses, wooden covered bridges, Roman aqueducts, iron train stations, etc. Term project should result in a publishable paper.

J. Ochsendorf

4.447J Design for Sustainability
(Same subject as 1.819J)
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit
See description under subject 1.819J.

J. Connor, J. Ochsendorf, E. Adams

4.448, 4.449 Special Problems in Structural Design
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Supplementary structural design on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.

Building Technology Staff

4.461 Building Technology I: Materials and Construction
Prereq: None
G (Fall)
3-1-5
Materials and methods of construction are essential elements of architectural design. In addition, static equilibrium is the first step in establishing architectural geometries in two- and three-dimensional space. Both topics are treated together and applied to selected contemporary construction systems and structural morphologies. Understanding of the integration of materials as functioning structural form is fostered in lectures, case studies, and field trips. Attention is paid to the importance of working details as part of a technically coordinated whole.

J. Fernandez

4.462 Building Structural Systems I
(Subject meets with 4.440)
Prereq: 4.461 or permission of instructor
G (Spring)
3-2-4
Introduces the design and behavior of large-scale structures and structural materials. Emphasizes the development of structural form and the principles of structural design. Introduces design methods for timber, masonry, concrete, and steel applied to long-span roof systems, bridges, and high-rise buildings. Includes environmental assessment of structural systems and materials. Laboratory to solve structural problems by building and testing simple models. Graduate and undergraduate students have separate lab sections.

J. Ochsendorf

4.463 Building Technology III: Building Structural Systems II
Prereq: 4.440, 4.462, or permission of instructor
G (Fall)
3-2-4
Addresses advanced structures, exterior envelopes, and contemporary production technologies. Continues the exploration of structural elements and systems, expanding to include more complex determinate, indeterminate, long-span, and high-rise systems. Topics include reinforced concrete, steel and engineered-wood design, and an introduction to tensile systems. The contemporary exterior envelope is discussed with an emphasis on the classification of systems, their performance attributes, and advanced manufacturing technologies.

J. Fernandez, J. Ochsendorf

4.464 Building Technologies IV: Energy in Building Design
Prereq: 4.463, or permission of instructor
G (Spring)
3-1-5
Explores aspects of climate relevant to building design, and applies concepts and methods to energy-efficient and environmentally responsible building design. Topics include climate and comfort parameters, energy systems, and environmental implications of building. Emphasizes practical applications for environmental design.

L. Glicksman, L. Norford

4.481 Building Technology Seminar
Prereq: Permission of instructor
G (Fall)
2-0-1 H-LEVEL Grad Credit
Introduction to ongoing research activities in building technology and development of student research projects. Topics drawn from indoor air quality and thermal comfort, building systems analysis and control, building energy uses, daylighting, structures, and new building materials and construction techniques. Organized as a series of two- to three-week sessions that consider topics through readings, discussions, design and analysis projects, and student presentations.

J. Fernandez, L. R. Glicksman, L. K. Norford, J. Ochsendorf, M. Andersen

4.488 Preparation for SMBT Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Building Technology Staff

4.489 Preparation for Building Technology PhD Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Building Technology Staff

4.481 Building Technology Seminar
Prereq: Permission of instructor
G (Fall)
2-0-1 H-LEVEL Grad Credit
Introduction to ongoing research activities in building technology and development of student research projects. Topics drawn from indoor air quality and thermal comfort, building systems analysis and control, building energy uses, daylighting, structures, and new building materials and construction techniques. Organized as a series of two- to three-week sessions that consider topics through readings, discussions, design and analysis projects, and student presentations.

J. Fernandez, L. R. Glicksman, L. K. Norford, J. Ochsendorf, M. Andersen

4.488 Preparation for SMBT Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Building Technology Staff

4.489 Preparation for Building Technology PhD Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Building Technology Staff
4.491–4.493 Special Problems in Building Technology
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
4.494 Special Problems in Building Technology
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
4.495 Special Problems in Building Technology
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
4.497, 4.498 Special Problems in Building Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.

Building Technology Staff

4.500 Introduction to Design Computing
Prereq: None
U (Fall)
2-2-8
Introduces students to architectural design and computation through the use of computer modeling, rendering, and digital fabrication. Focus on the exploration of space- and place-making through the use of computer rendering and design construction through CAD/CAM fabrication. Students design a small building using computer models leading to a full package of physical and virtual materials, from computer generated drawings to rapid, prototyped models. Enrollment limited to 24; preference to Course 4 majors and minors.
L. Sass

4.502 Design Scripting
(Subject meets with 4.564)
Prereq: 4.500
U (Spring)
2-2-8
Introduces fundamental ideas of computer programming and demonstrates their application to the process of visual and spatial design. Teaches methods for algorithmically modeling visual and spatial forms, evaluating their conditions, building interface, and processing formal data for prototyping, manufacturing, rendering, and other design tools. Proceeds through a sequence of scripting exercises in application programming environments. Each exercise requires a student to articulate computational tasks in the context of a design, and to write codes that produce graphic solutions. Additional work required of students taking the graduate version.
T. Nagakura, D. Shelden

4.503 Advanced Visualization: Architecture in Motion Graphics
(Subject meets with 4.562)
Prereq: 4.500 or permission of instructor
U (Fall)
2-2-8
Advanced projects in architectural visualization with an emphasis on the use of computer graphics animation and video production media. Workshop introduces advanced visualization software and teaches exploration of spatial expressions in motion graphics format. Students review and discuss selected literature and video materials on architecture and film. Workshop format. Additional work required of students taking the graduate version.
T. Nagakura

4.505 Computation Design Workshop
Prereq: 4.501, 4.502, 4.503
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-3-6
Project-based subject that provides opportunities to explore and integrate the various skills, theories, and technologies introduced in prerequisite subjects. Strategies and computational tools for rule-based and parametric design are introduced, critically examined, and explored through application to practical design tasks. Students gain experience with techniques of design synthesis, performance analysis and simulation, visualization, fabrication, and assembly, and with strategies for collaboration and coordination. Emphasis on creative response to challenging design problems.
T. Knight, W. Mitchell

4.510 Materializing Design
Prereq: Permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit
Introductory subject in advanced computing, rapid prototyping, and CAD/CAM fabrication for architects. Focuses on the relationship between design and various forms of computer modeling/CAD/CAM tools as output material. Presents the process of design and construction, using CAD files for construction. Taught in phases, starting with CAD/CAM and ending with rapid prototyping of building components fabricated from CAD files. Limited to 36.
L. Sass

4.512 Special Projects in Architectural Digital Fabrication
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Individual research or project team work with digital fabrication software and devices in the computational design process.
L. Sass

4.513 Special Problems in Digital Fabrication
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
4.514 Special Problems in Digital Fabrication
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Supplementary work on the topic of digital fabrication. For individual research or project team work in advancing understanding of digital fabrication software and devices in the computational design process.
L. Sass

4.520 Computational Design I: Theory and Applications
(Subject meets with 4.521)
Prereq: None
U (Fall)
3-0-9
Introduces design as a computational enterprise in which rules are developed to compose and describe architectural and other designs. Topics...
include shapes, shape arithmetic, symmetry, spatial relations, shape computations, and shape grammars. Focuses on the application of shape grammars in creative design. Teaches shape grammar fundamentals through exercises with abstract shape grammars. Discusses issues related to practical applications of shape grammars.

T. Knight

4.521 Computational Design I: Theory and Applications
(Subject meets with 4.520)
Prereq: None
G (Fall)
3-0-6

See description under subject 4.520.

T. Knight

4.522 Computational Design II: Theory and Applications
(Subject meets with 4.523)
Prereq: 4.520 or permission of instructor
U (Spring)
3-0-9

Introduces advanced topics in shape grammar theory and applications. Includes an introductory component on shape grammars for students new to the area. Discusses generalizations of the shape grammar formalism that permit greater flexibility in computing designs. These include parametric grammars and parametric design, parallel grammars, and color grammars. Introduces color grammars through exercises. Discusses the generative and expressive powers of grammars in relation to other computational design systems. Additional work required of graduate students.

T. Knight

4.523 Computational Design II: Theory and Applications
(Subject meets with 4.522)
Prereq: 4.520, 4.521 or permission of instructor
G (Spring)
3-0-6

See description under subject 4.522.

T. Knight

4.540 Introduction to Shape Grammars I
Prereq: None
G (Fall)
3-0-6

An in-depth introduction to shape grammars and their applications in architecture and related areas of design. Shapes in the algebras Ui j, in the algebras Vi j and Wi j incorporating labels and weights, and in algebras formed as composites of these. Rules and computations, shape and structure, designs. G. Stiny

4.541 Introduction to Shape Grammars II
Prereq: 4.540
G (Spring)
3-0-6 H-LEVEL Grad Credit

An in-depth introduction to shape grammars and their applications in architecture and related areas of design. Shapes in the algebras Ui j, in the algebras Vi j and Wi j incorporating labels and weights, and in algebras formed as composites of these. Rules and computations. Shape and structure. Designs. G. Stiny

4.542 Background to Shape Grammars
Prereq: 4.541 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor

An advanced examination of the shape grammar formalism and its relationship to some key issues in a variety of other fields, including art and design, philosophy, history and philosophy of science, linguistics and psychology, literature and literary studies, logic and mathematics, and artificial intelligence. Student presentations and discussion of selected readings are encouraged. Topics vary from year to year. G. Stiny

4.543 Special Problems in Shape Grammars
Prereq: 4.520, 4.540, or permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

An opportunity to use shape grammars or related algorithmic devices to characterize detailed designs in a historical corpus or original designs conceived from scratch. Projects may have their focus in architecture or in any other area of design (e.g. product design) where there is a strong interaction between form and function. Questions of style and stylistic change, type, and value stressed in relationship to shape grammars and the algorithmic processes they encourage. Project work may extend over multiple terms. Computation Staff

4.550–4.551 Workshop in Architectural Computation
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

4.552–4.555 Workshop in Architectural Computation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Opportunity for group exploration of a special topic in computation through research-focused design projects or exercises. Registration subject to prior arrangement of topic and supervision by staff.

Computation Staff

4.556] Design Without Boundaries
(Same subject as MAS.551J)
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit

See description under subject MAS.551J.
W. Mitchell, F. Casalegno

4.557] Mobility-on-Demand (New)
(Same subject as MAS.552J)
Prereq: Permission of instructor
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject MAS.552J.
W. Mitchell

4.560 Geometric Modeling
Prereq: Permission of instructor
G (Fall)
2-2-8

Introduces the fundamentals of three-dimensional geometric modeling and associated computer-aided design as well as visualization applications in architecture, urban design, and computer graphics production. Provides a theoretical foundation to a selection of current hardware and software tools. Extensive opportunities to develop practical skills through lab sessions and regular practical exercises. Background in computational skills is an advantage, but not required. Students acquire the skills necessary to undertake independent CAD projects in design studios or other professional settings.

T. Nagakura
4.562 Advanced Visualization: Architecture in Motion Graphics  
(Subject meets with 4.503)  
Prereq: 4.560 or permission of instructor  
G (Fall)  
2-2-8 H-LEVEL Grad Credit  
Advanced projects in architectural visualization with an emphasis on the use of computer graphics animation and video production media. Workshop introduces advanced visualization software and teaches exploration of spatial expressions in motion graphics format. Students review and discuss selected literature and video materials on architecture and film. Workshop format. Additional work required of students taking the graduate version.  
T. Nagakura

4.564 Design Scripting  
(Subject meets with 4.502)  
Prereq: 4.560 or permission of instructor  
G (Spring)  
2-2-8 H-LEVEL Grad Credit  
Introduces fundamental ideas of computer programming and demonstrates their application to the process of visual and spatial design. Teaches methods for algorithmically modeling visual and spatial forms, evaluating their conditions, building interface, and processing formal data for prototyping, manufacturing, rendering, and other design tools. Proceeds through a sequence of scripting exercises in application programming environments. Each exercise requires a student to articulate computational tasks in the context of a design, and to write codes that produce graphic solutions. Additional work required of students taking the graduate version.  
T. Nagakura, D. Shelden

4.566 Advanced Projects in Digital Media  
Prereq: 4.562, 4.564 or permission of instructor  
G (Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit  
Develop independent projects in the study of digital media as it relates to architectural design. Students propose a project topic such as digital design tool, modeling and visualization, motion graphics, design knowledge representation and media interface.  
T. Nagakura

4.580 Inquiry into Computation and Design  
Prereq: None  
G (Fall)  
3-0-9  
Explores the varied nature and practice of computation in design. Different computational approaches for understanding and thinking about design, and for doing design, are introduced through lectures, readings, discussions, and guest visits by Computation group faculty and others. Topics may vary from year to year. Aims to develop a critical view and awareness of assumptions about computation in design beyond the specifics of techniques and tools, and to open avenues for further research.  
T. Knight

4.581 Proseminar in Computation  
Prereq: Permission of instructor  
G (Fall, Spring)  
3-0-9 [P/D/F] H-LEVEL Grad Credit  
Introduction to traditions of research in design and computation scholarship.  
G. Stiny

4.582 Research Seminar in Computation  
Prereq: 4.580  
G (Fall, Spring)  
3-0-9 [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit  
In-depth presentations of current research in design and computation.  
Computation Staff

4.583 Forum in Computation  
Prereq: Permission of instructor  
G (Fall, Spring)  
3-0-0 [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit  
Group discussions and presentation of ongoing graduate student research in the Computation program.  
Computation Staff

Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit  
Computation Staff

4.590 Special Problems in Architectural Computation  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit

4.591 Special Problems in Architectural Computation  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit  
Opportunity for individual or group pursuit of topics not covered by regular Computation offerings. Registration subject to prior arrangement of topic and supervision by staff.  
Computation Staff

4.592 Special Problems in Computation  
Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit

4.593 Special Problems in Computation  
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit

4.598 Special Problems in Computation  
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit

4.599 Special Problems in Computation  
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit  
Opportunity for individual or group pursuit of topics not covered by regular Computation offerings. Registration subject to prior arrangement of topic and supervision by staff.  
Computation Staff

4.601 Introduction to Art History  
Prereq: None  
U (Fall)  
3-2-7 HASS-D, Category 3  
Introduction to the history of western art that explores painting, graphic arts and sculpture from the Renaissance to the present. Engages diverse methodological perspectives to examine changing conceptions of art and the artist, and to investigate the plural meaning of artworks within the larger contexts of culture and history. Subject includes trips to local museums.  
K. Smentek
4.602 Modern Art and Mass Culture
Prereq: None
U (Spring)
4-0-8 HASS-D, Category 3, CI-H
Introduction to modern art and theories of modernism and postmodernism. Focuses on the way artists use the tension between fine art and mass culture to mobilize a critique of both. Examines objects of visual art, including painting, sculpture, architecture, photography, prints, performance and video. These objects are viewed in their interaction with advertising, caricature, comics, graffiti, television, fashion, folk art, and “primitive” art.
K. Smentek

4.605 Introduction to the History and Theory of Architecture
Prereq: None
U (Fall)
4-0-8 HASS-D, Category 3
Provides an outline of the history of architecture and urbanism from Ancient Egypt to the present. Analyzes buildings as the products of culture and in relation to the special problems of architectural design. History of architecture with an urbanist perspective that stresses the cultural and political context from which building arises. Designed to develop critical tools used in the analysis and appreciation of architecture for its role in creating the intellectual environment in which we conduct our lives. Instruction and practice in oral and written communication provided.
D. H. Friedman

4.607 Thinking About Architecture: In History and At Present
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Studies the interrelationship of theory, history, and practice. Looks at theory not as specialized discourse relating only to architecture, but as touching on many issues, whether they be cultural, aesthetic, philosophical, or professional. Topics and examples are chosen from a wide range of materials, from classical antiquity to today.
M. Jarzombek

4.609 Seminar in the History of Art and Architecture
Prereq: Permission of instructor
U (Fall, Spring)
3-0-9
Examination of historical method in art and/or architecture focusing on periods and problems determined by the research interest of the faculty member leading the seminar. Emphasis on critical reading and viewing and direct tutorial guidance. Extensive discussion.
HTC Staff

4.611 Civic Architecture in Islamic History
(Subject meets with 4.613)
Prereq: None
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
Units arranged
4.613 Civic Architecture in Islamic History
(Subject meets with 4.611)
Prereq: None
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9 HASS
Chronological survey of palatial, residential, governmental, military, commercial, and landscape architecture in the Islamic world. Examines the influence of Islamic culture and historic events on the formation and development of architectural traditions, and their possible models, survival, and regional transformations. Additional work required of students taking the graduate version.
N. Rabbat

4.614 Religious Architecture and Islamic Cultures
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 3
Introduces the history of Islamic cultures through their most vibrant material signs: the religious architecture that spans fourteen centuries and three continents—Asia, Africa, and Europe. Studies a number of representative examples from the House of the Prophet to the present in conjunction with their social, political, and intellectual environments. Presents Islamic architecture both as a full-fledged historical tradition and as a dynamic and interactive cultural catalyst that influenced and was influenced by the civilizations with which it came in contact.
N. Rabbat

4.616 Cultural Signification in Architecture
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
Units arranged H-LEVEL Grad Credit
Seminar on the issue of meaning in architecture. Establishes historical and theoretical frameworks for investigations. Analyzes traditions, transformations, and inventions in architecture as a conveyor of messages that transcend the stylistic, formal, and iconographic domains to include an assessment of some of the political, ideological, social, and cultural concerns of the builders and patrons both synchronically and diachronically. Critically reviews the methodologies and theoretical premises of studies on meaning and iconography in Islamic architecture.
N. Rabbat

4.617 Issues in Islamic Urbanism
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
Units arranged H-LEVEL Grad Credit
Seminar on selected topics from Islamic urban history. Examines patterns of settlement, urbanization, development and architectural production in various places and periods from late antiquity to the present. Discusses the leading factors in shaping and transforming civic forms, urban plans, cultural and economic structures and social attitudes. Critically analyzes the body of literature concerned with the ancient, medieval Islamic, colonial, and post colonial city types. Research paper required. Open to qualified undergraduates.
N. Rabbat

4.619 Historiography of Islamic Architecture
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Critical review of literature on Islamic architecture in the last two centuries and analysis of its historical and theoretical frameworks. Challenges the tacit assumptions and biases of standard studies of Islamic architecture and addresses historiographic and critical questions concerning how knowledge of a field is defined, produced, and reproduced.
N. Rabbat

4.621 Orientalism and Representation
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
Units arranged H-LEVEL Grad Credit
Seminar on the historiography and politics of representation with special focus on Orientalist traditions in architecture, art, literature, and scholarship. Critically analyzes pivotal texts, projects, and images that informed the cross-cultural encounters between Europe and the “Orient” from Antiquity to the present. Discusses how political and ideological attitudes and beliefs informed both the construction and reproduction of European knowledge about the Islamic world as well as the revisionist

N. Rabbat

4.623 Mughal Landscapes: History, Heritage, and Design (New)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Seminar focuses on environmental design in the Mughal empire of South Asia, a dynasty of Central Asian origins that extended over the current territories of India, Pakistan, Bangladesh, and Afghanistan. Topics include gardens, cities, cultural landscapes, and political territories, along with their contemporary significance for cultural heritage conservation and design. Enrollment limited to 15.

J. Wescoat

4.625) Water Reading Group (New)
(Same subject as 11.378J)
Prereq: Permission of instructor
G (Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Interdisciplinary focus on water in environmental history, planning, policy, and design. Draws together faculty and students who are working on water-related research projects to develop and maintain a broad and current perspective on the field. Limited to 15.

J. Wescoat

4.627 Special Problems in Islamic and Non-Western Architecture
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged Can be repeated for credit

4.628, 4.629 Special Problems in Islamic and Non-Western Architecture
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Supplementary work on individual or group basis in the history, theory, and criticism of architecture and urban form in the Islamic World. Registration subject to prior arrangement for subject matter and supervision by staff.

N. Rabbat, J. Wescoat

4.634 Renaissance Architecture
(Subject meets with 4.635)
Prereq: None
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
Units arranged

4.635 Renaissance Architecture
(Subject meets with 4.634)
Prereq: 4.605
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9 HASS
A history of architectural design, architectural practice, and the role of architecture in the culture and society of Renaissance Italy. Topics include the formation and development of the modern classical style, the new techniques of architectural drawing, the relationship of architecture to the new visual culture, the role of architecture in the transformation of the political structure of Italy. Graduate students are expected to complete additional assignments.

D. H. Friedman

4.638 Advanced Study in Renaissance Architecture
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Seminar on a selected topic from Renaissance architecture. Requires original research and presentation of a report.

D. H. Friedman

4.640 Advanced Study in Critical Theory of Architecture
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Seminar on a selected topic in critical theory. Requires original research and presentation of oral and written report.

A. Dutta

4.641 19th-Century Art
(Subject meets with 4.644)
Prereq: None
U (Spring)
4-0-8 HASS
Survey of visual culture from the late 18th century to 1900 with an emphasis on Western Europe and its non-European points of contact. Topics include art and revolution, empire and its image, mythologies of the artist, gender and representation, public exhibitions and the dealer/critic system, and the emergence of the avant-garde. Strives a balance between historical and contemporary critical perspectives to assess art’s engagement with social and political experience. Additional work required of students taking the graduate version.

K. Smentek

4.642 Advanced Study in Modern Art
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Seminar on a selected topic from modern art, stressing theoretical or critical issues of contemporary concern. Requires original research and presentation of oral and written reports.

HTC Staff

4.644 19th-Century Art
(Subject meets with 4.641)
Prereq: None
G (Spring)
4-0-5
Survey of visual culture from the late 18th century to 1900 with an emphasis on Western Europe and its non-European points of contact. Topics include art and revolution, empire and its image, mythologies of the artist, gender and representation, public exhibitions and the dealer/critic system, and the emergence of the avant-garde. Strives a balance between historical and contemporary critical perspectives to assess art’s engagement with social and political experience. Additional work required of students taking the graduate version.

K. Smentek

4.645 Selected Topics in Architecture—1750 to the Present
Prereq: 4.605
G (Fall)
3-0-6
General study of modern architecture as a response to important technological, cultural, environmental, aesthetic, and theoretical challenges after the European Enlightenment. Focus on the theoretical, historiographic, and design approaches to architectural problems encountered in the age of industrial and post-industrial expansion across the globe, with specific attention to the dominance of European modernism in setting the agenda for the discourse of a global modernity at large. Explores modern architectural history through thematic exposition rather than as simple chronological succession of ideas.

A. Dutta
ARCHITECTURE

4.651 Art Since 1940
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Critical examination of major developments in European, Asian, and American art from 1940 to the present. Surveys the effects of art’s engagements with modernization, radical politics, utopianism, mass culture, changing conceptions of mind and human nature, new technologies, colonialism and postcolonialism, and other significant aspects of recent history.
D. H. Friedman

4.654–4.656 Advanced Study in Modern Architecture
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Seminar or lecture on a selected topic in the architecture of the late 18th century to the present in Europe and America. Requires original research and presentation of oral and written reports.
S. Anderson

4.661 Theory and Method in the Study of Architecture and Art
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Studies theoretical and historiographical works pertaining to the fields of art and architectural history. Members of seminar pursue work designed to examine their own presuppositions and methods. Open only to PhD candidates and other advanced students.
M. Jarzombek

4.662 Advanced Study in the History of Urban Form
Prereq: Permission of instructor
G (Fall)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Seminar on a selected topic in the history of urban form. Requires original research and presentation of a report.
D. H. Friedman

4.663 History of Urban Form
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
Units arranged H-LEVEL Grad Credit
Studies in the history of the physical city from Antiquity to the present, with points of special focus determined by the instructor. Analyzes the typologies of urban buildings, public places, and city plans in their relation to changing contexts of culture, politics, and the structure of public and private institutions.
D. H. Friedman

4.665 Contemporary Architecture and Critical Debate
Prereq: 4.123 or 4.112
G (Spring)
3-0-6
Critical review of works, theories, and polemics in architecture in the aftermath of WWII. Aim is a historical understanding of the period and the development of a meaningful framework to assess contemporary issues in architecture. Special attention paid to historiographic questions of how architects construe the terms of their “present.”
S. Anderson

Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Special topics in the history, theory, and criticism of architecture and urban form, varying at the discretion of the instructor.
HTC Staff

4.670 Nationalism, Internationalism, and Globalism in Modern Art
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
Units arranged H-LEVEL Grad Credit
HTC Staff

4.673 Installation Art
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9
Focuses on a specific genre of contemporary art that produces environments rather than portable “art objects.” Installation art is viewed from a historical perspective, as a rejection of the modernist aesthetic of purity and the neutral white gallery space. This site-specific art is also seen to develop previous exhibition models such as natural history displays or merchandising conventions.
C. Jones

Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Advanced research and projects on topics in the history, theory, and criticism of architecture or art. Registration subject to prior arrangement for subject matter and supervision by staff.
HTC Staff

4.689 Preparation for History, Theory, and Criticism—PhD Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
HTC Staff
4.691 Special Studies in the History, Theory, and Criticism of Art
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit

4.692, 4.693 Special Studies in the History, Theory, and Criticism of Art
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit
Individual or group projects on topics in the history, theory, and criticism of art. Registration subject to prior arrangement for subject matter and supervision by staff.
C. Jones, E. Naginski

4.694 Special Studies in the History, Theory, and Criticism of Art and Architecture
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

4.695 Special Studies in the History, Theory, and Criticism of Architecture and Urban Form
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit

Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

4.699 Special Studies in the History, Theory, and Criticism of Art and Architecture
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Individual and group projects in the history, theory, and criticism of art and/or architecture. Registration subject to prior arrangement for subject matter and supervision by staff.
HTC Staff

4.THTJ Thesis Research Design Seminar
(Same subject as 11.THTJ)
Prereq: None
U (Fall)
3-0-9
Can be repeated for credit
See description under subject 11.THTJ.
C. Abbanat

4.ThU Undergraduate Thesis
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit
Program of thesis research leading to the writing of an SB thesis, to be arranged by the student and an appropriate MIT faculty member. Intended for seniors. 12 units recommended.
Architecture Staff

4.JR Undergraduate Research in Architecture
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

4.URG Undergraduate Research in Architecture
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Research and project activities, which cover the range represented by the various research interests and projects in the department. Students who wish a letter grade option for their work must register for 4.URG.
J. Ochsendorf

4.ThG Graduate Thesis
Prereq: None
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research and writing of thesis; to be arranged by the student with supervising committee.
Staff
### Bachelor of Science in Art and Design/Course 4

#### General Institute Requirements (GiRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [one subject can be satisfied by a subject in the Departmental Program]**</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**: 17

#### Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- 2 subjects designated as Communication Intensive in the Major (CI-M).

#### PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites if any (corequisites in italics)

**Required Subjects**

<table>
<thead>
<tr>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.111 Experiencing Architecture Studio</td>
<td>12</td>
</tr>
<tr>
<td>4.112 Integrated Architecture Design Studio</td>
<td>12</td>
</tr>
<tr>
<td>or 4.112A Integrated Architecture Design Studio Intensive Studio</td>
<td>9; 4.111</td>
</tr>
<tr>
<td>4.302 Foundations in the Visual Arts for Majors</td>
<td>12</td>
</tr>
<tr>
<td>4.401 Introduction to Building Technology</td>
<td>12</td>
</tr>
<tr>
<td>4.500 Introduction to Design Computing</td>
<td>12</td>
</tr>
</tbody>
</table>

**Discipline Stream Subjects**

By the beginning of their junior year, students are expected to begin concentrating in one of the five discipline streams.

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#### Architectural Design Discipline Stream

<table>
<thead>
<tr>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.113 Applied Architecture Design Studio I</td>
<td>15; 4.112*</td>
</tr>
<tr>
<td>4.114 Applied Architecture Design Studio II</td>
<td>21, CI-M</td>
</tr>
<tr>
<td>4.115 Applied Architecture Design Studio III</td>
<td>21; 4.114</td>
</tr>
<tr>
<td>4.205 Analysis of Contemporary Architecture</td>
<td>12, HASS</td>
</tr>
<tr>
<td>4.440 Basic Structural Design, 12, REST; Calculus II (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>4.605 Introduction to the History and Theory of Architecture, 12, HASS-D</td>
<td>12</td>
</tr>
<tr>
<td>4.116 Advanced Architecture Design Studio II</td>
<td>21; 4.115, 4.440</td>
</tr>
<tr>
<td>or Two subjects from any one of the other four discipline streams</td>
<td></td>
</tr>
</tbody>
</table>

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#### Building Technology Discipline Stream

<table>
<thead>
<tr>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.411 Building Technology Laboratory, 12; LAB; Physics II (GIR), Calculus II (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>4.440 Basic Structural Design, 12, REST; Calculus II (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>4.605 Introduction to the History and Theory of Architecture, 12, HASS-D</td>
<td>12</td>
</tr>
<tr>
<td>4.THTJ Thesis Research Design Seminar, 12, CI-M</td>
<td>12</td>
</tr>
<tr>
<td>4.THU Undergraduate Thesis, 12</td>
<td></td>
</tr>
</tbody>
</table>

Four additional subjects in Building Technology

One additional subject from any of the other four discipline streams

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#### Computation Discipline Stream

<table>
<thead>
<tr>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.501 Architectural Construction and Computation, 12; 4.500</td>
<td>12</td>
</tr>
<tr>
<td>4.502 Design Scripting, 12; 4.500</td>
<td>12</td>
</tr>
<tr>
<td>4.503 Advanced Visualization: Architecture in Motion Graphics, 12; 4.500</td>
<td>12</td>
</tr>
<tr>
<td>4.505 Computational Design Workshop, 12; 4.501, 4.502, 4.503</td>
<td>12</td>
</tr>
<tr>
<td>4.605 Introduction to the History and Theory of Architecture, 12, HASS-D</td>
<td>12</td>
</tr>
<tr>
<td>4.THTJ Thesis Research Design Seminar, 12, CI-M</td>
<td>12</td>
</tr>
<tr>
<td>4.THU Undergraduate Thesis, 12</td>
<td></td>
</tr>
</tbody>
</table>

One additional subject in Computation

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#### History, Theory, and Criticism of Architecture and Art Discipline Stream

<table>
<thead>
<tr>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.601 Introduction to Art History, 12, HASS-D</td>
<td>12</td>
</tr>
<tr>
<td>4.605 Introduction to the History and Theory of Architecture, 12, HASS-D</td>
<td>12</td>
</tr>
<tr>
<td>4.602 Modern Art and Mass Culture, 12, HASS-D, CI-H</td>
<td>12</td>
</tr>
<tr>
<td>or 4.641 19th-Century Art, 12, HASS</td>
<td></td>
</tr>
<tr>
<td>or 4.651 Art Since 1940, 12, HASS</td>
<td></td>
</tr>
<tr>
<td>4.613 Civic Architecture in Islamic History, 12, HASS-D</td>
<td>12</td>
</tr>
<tr>
<td>or 4.614 Religious Architecture and Islamic Cultures, 12, HASS-D</td>
<td>12</td>
</tr>
<tr>
<td>4.THTJ Thesis Research Design Seminar, 12, CI-M</td>
<td>12</td>
</tr>
<tr>
<td>4.THU Undergraduate Thesis, 12</td>
<td></td>
</tr>
</tbody>
</table>

Three additional subjects in History, Theory, and Criticism of Architecture and Art

One additional subject in Visual Arts

### Visual Arts Discipline Stream

**Course Requirements**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.322</td>
<td>Introduction to Three-Dimensional Art Work, 12, HASS</td>
<td>12</td>
</tr>
<tr>
<td>4.341</td>
<td>Introduction to Photography and Related Media, 12, HASS</td>
<td>12</td>
</tr>
<tr>
<td>4.351</td>
<td>Introduction to Video, 12, HASS</td>
<td>12</td>
</tr>
<tr>
<td>4.441</td>
<td>Introduction to Art History, 12, HASS-D</td>
<td>12</td>
</tr>
<tr>
<td>4.THTJ</td>
<td>Thesis Research Design Seminar, 12, CI-M</td>
<td>12</td>
</tr>
<tr>
<td>4.THU</td>
<td>Undergraduate Thesis, 12</td>
<td>12</td>
</tr>
</tbody>
</table>

Three intermediate/advanced-level subject in Visual Arts

One additional subject in History, Theory, and Criticism of Art

**Departmental Program Units That Also Satisfy the GIRs**

| Units | 36 |

**Unrestricted Electives**

| Units | 48–57 |

**Total Units Beyond the GIRs Required for SB Degree**

| Units | 192 |

No subject can be counted both as part of the 17-subject GIRs and as part of the 192 units required beyond the GIRs. Every subject in the student's departmental program will count toward one or the other, but not both.

**Notes**

*Alternate prerequisites are listed in the subject description.*

**Only three subjects required by the department may also satisfy the General Institute Requirements. Students in the Visual Arts departmental discipline stream may not have a HASS concentration in Visual Arts; nor may History, Theory, and Criticism of Architecture and Art discipline stream students concentrate in the HASS field of History of Art and Architecture.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
5.00 Applications of Technology in Energy and the Environment
Engineering School-Wide Elective Subject
(Offered under: 1.149, 2.63, 5.00, 10.579, 22.813, ESD.174)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.813.
J. Deutch, R. Lester

5.03 Principles of Inorganic Chemistry I
Prereq: 5.12
U (Spring)
4-0-8
Presents principles of chemical bonding and molecular structure, and their application to the chemistry of representative elements of the periodic system.
C. Cummins

5.04 Principles of Inorganic Chemistry II
Prereq: 5.03
U (Fall)
4-0-8
Systematic presentation of the chemical applications of group theory. Emphasis on the formal development of the subject and its applications to the physical methods of inorganic chemical compounds. Against the backdrop of electronic structure, the electronic, vibrational, and magnetic properties of transition metal complexes are presented and their investigation by the appropriate spectroscopy described.
D. G. Nocera

5.05 Principles of Inorganic Chemistry III
Prereq: 5.03, 5.04
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit
Principles of main group (s and p block) element chemistry with an emphasis on synthesis, structure, bonding, and reaction mechanisms.
C. C. Cummins

5.061 Principles of Organometallic Chemistry
Prereq: 5.03
G (Fall; second half of term)
2-0-4 H-LEVEL Grad Credit
A comprehensive treatment of organometallic compounds of the transition metals with emphasis on structure, bonding, synthesis, and mechanism.
J. C. Peters

5.062 Principles of Bioinorganic Chemistry
Prereq: 5.03
G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
Delineates principles that form the basis for understanding how metal ions function in biology. Includes the choice, uptake and assembly of metal-containing units; metal-induced folding of biomolecules; control of metal ion concentrations in cells; electron-transfer chemistry; atom and group transfer chemistry; protein tuning of metal properties; and applications to diagnosis and treatment of disease.
S. J. Lippard

5.063 Organometallic Compounds in Catalytic Reactions
Prereq: 5.061
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
An exploration of organometallic chemistry from the perspective of catalytic reactions in organic and polymer chemistry.
R. Schrock

5.067 Crystal Structure Refinement
Prereq: 5.068, 5.069, or permission of instructor
G (Fall; first half of term)
1-2-3 H-LEVEL Grad Credit
Practical aspects of crystal structure determination from data collection strategies to data reduction and basic and advanced refinement problems of organic and inorganic molecules.
P. Mueller

5.068 Physical Inorganic Chemistry
Prereq: 5.03, 5.04
G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit
Discussion of physical methods used to probe the electronic and geometric structures of inorganic compounds. Included are resonance Raman spectroscopy, solid state and solution magnetochemical methods, electron paramagnetic resonance spectroscopy, advanced EPR methods (ENDOR AND ESEEM), cryoreduction to create EPR-active states, X-ray absorption spectroscopy (XANES and EXAFS), Mössbauer spectroscopy, and advanced kinetic and electrochemical methods. Applications to current research problems in inorganic and bioinorganic chemistry.
S. J. Lippard

5.069 Crystal Structure Analysis
Prereq: 5.03, 5.04
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
Introduction to X-ray crystallography: symmetry in real and reciprocal space, space and Laue groups, geometry of diffraction, structure factors, phase problem, direct and Patterson methods, electron density maps, structure refinement, crystal growth, powder methods, limits of diffraction methods, structure data bases.
P. Mueller

5.07J Biological Chemistry I
(Same subject as 20.507J)
Prereq: 5.12
U (Fall)
4-0-8 REST
Credit cannot also be received for 7.05
Chemical and physical properties of the cell and its building blocks. Structures of proteins and principles of catalysis. The chemistry of organic/inorganic cofactors required for chemical transformations within the cell. Basic principles of metabolism and regulation in pathways, including glycolysis, gluconeogenesis, fatty acid synthesis/degradation, pentose phosphate pathway, Krebs cycle and oxidative phosphorylation, DNA replication, and transcription and translation.
J. Essigmann, J. Stubbe
chemistry of the carbonyl group. Introduction to the chemistry of aromatic compounds.
Fall: S. E. O'Connor, B. Imperiali
Spring: R. L. Danheiser, T. F. Jamison

5.13 Organic Chemistry II
Prereq: 5.12
U (Fall)
5-0-7
Intermediate organic chemistry. Synthesis, structure determination, mechanism, and the relationships between structure and reactivity emphasized. Special topics in organic chemistry included to illustrate the role of organic chemistry in biological systems and in the chemical industry.
M. Movassaghi

5.24J Archaeological Science
(Same subject as 3.985J, 12.011J)
Prereq: Chemistry (GIR) or Physics I (GIR)
U (Spring)
3-1-5 HASS
See description under subject 3.985J.
H. N. Lechtmann, J. Stubbe, F. A. Frey

5.301 Laboratory Techniques in Chemistry
Prereq: Chemistry (GIR), permission of instructor U (IAP)
1-4-1 [P/D/F]
Practical training in basic chemistry laboratory techniques. Intended to provide freshmen with the skills necessary to undertake original research projects in chemistry. Freshmen only. Enrollment limited.
J. Dolhun

5.302 Introduction to Experimental Chemistry
Prereq: Chemistry (GIR); permission of instructor Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (IAP)
0-3-0 [P/D/F]
Illustrates fundamental principles of chemical science through hands-on experience with chemical phenomena. Freshmen only. Enrollment limited.
Staff

5.310 Laboratory Chemistry
Prereq: None. Coreq: 5.12
U (Fall, Spring)
2-8-2 Institute LAB
Introduces experimental chemistry for students who are not majoring in Course 5. Principles and applications of chemical laboratory techniques, including preparation and analysis of chemical materials, measurement of pH, gas and liquid chromatography, visible-ultraviolet spectrophotometry, infrared spectroscopy, kinetics, data analysis, and elementary synthesis. Enrollment limited.
J. Dolhun

5.35J Introduction to Experimental Chemistry
(Subject meets with 5.35U)
Prereq: See module descriptions
U (Fall, Spring)
Can be repeated for credit

This 12-unit subject consists of 3 modules, which may be taken during different terms. Modules and prerequisites are as follows:
— Module 1 (Prereq: 5.111, 5.112 or 3.091)
Survey of spectroscopy.
— Module 2 (Prereq: 5.111, 5.112 or 3.091; Module 1) Synthesis of coordination compounds and kinetics.
— Module 3 (Prereq: 5.111, 5.112 or 3.091; Module 2) Fabrication of a polymeric light emitting device.
 Enrollment limited; preference to Course 5 majors.
Fall: L. Cai (Modules 1 and 2), T. Swager (Module 3)
Spring: C. Degen (Modules 1 and 2), T. Swager (Module 3)

5.35U Introduction to Experimental Chemistry
(Subject meets with 5.35)
Prereq: See module descriptions under subject 5.35
U (Fall, Spring)
Can be repeated for credit

For students who might not take all modules of 5.35. Consult department when choosing a version of 5.35. See description for 5.35. May be taken for 8 or 4 units and repeated for credit up to a total of 12 units.
Fall: L. Cai (Modules 1 and 2), T. Swager (Module 3)
Spring: C. Degen (Modules 1 and 2), T. Swager (Module 3)

5.36 Biochemistry and Organic Laboratory
(Subject meets with 5.36U)
Prereq: See module descriptions
U (Fall, Spring)
Can be repeated for credit

This 12-unit subject consists of 3 modules, which may be taken during different terms. Instruction and practice in the written and oral presentation of experimental results provided. Modules and prerequisites are as follows:
— Module 4 Spring (Prereq: 5.07 or 7.05, Module
2 or 5.310, Module 5) Expression and Purification of Enzyme Mutants. Must be taken simultaneously with Module 5.

—Module 5 Spring (Prereq: 5.07 or 7.05, Module 2 or 5.310, Module 4) Kinetics of Enzyme Inhibition. Must be taken simultaneously with Module 4.

—Module 6 Fall (Prereq: 5.12, Module 2 or 5.310, 5.13) Organic Structure Determination. Enrollment limited; preference to Course 5 majors.

Fall: R. L. Danheiser (Module 6)
Spring: E. Vogel Taylor (Modules 4 and 5)

5.36U Biochemistry and Organic Laboratory
(Subject meets with 5.36)
Prereq: See module descriptions under subject 5.36
U (Fall, Spring)
Units arranged
Can be repeated for credit

For students who might not take all modules of 5.36. Consult department when choosing a version of 5.36. See description for 5.36. May be taken for 8 or 4 units and repeated for credit up to a total of 12 units.

Fall: R. L. Danheiser (Module 6)
Spring: E. Vogel Taylor (Modules 4 and 5)

5.37 Organic and Inorganic Laboratory
(Subject meets with 5.37U)
Prereq: See module descriptions
U (Fall, Spring)
Units arranged
Can be repeated for credit

This 12-unit subject consists of 3 modules, which may be taken during different terms. Modules and prerequisites are as follows:
—Module 7 Spring (Prereq: 5.13, Module 6) Introduction to Organic Synthesis.
—Module 8 Fall (Prereq: 5.03, Module 6, 5.61) Two Electron Bond.
—Module 9 Fall (Prereq: 5.03, Module 6, 5.61) Dinitrogen Cleavage.

Enrollment limited; preference to Course 5 majors.

Fall: D. Nocera (Module 8), C. Cummins (Module 9)
Spring: R. L. Danheiser (Module 7)

5.37U Organic and Inorganic Laboratory
(Subject meets with 5.37)
Prereq: See module descriptions under subject 5.37
U (Fall, Spring)
Units arranged
Can be repeated for credit

For students who might not take all modules of 5.37. Consult department when choosing a version of 5.37. See description for 5.37. May be taken for 8 or 4 units and repeated for credit up to a total of 12 units.

Fall: D. Nocera (Module 8), C. Cummins (Module 9)
Spring: R. L. Danheiser (Module 7)

5.38 Physical Chemistry Laboratory
Prereq: See module descriptions
U (Spring)
Units arranged
Can be repeated for credit

This 12-unit subject consists of 3 modules, which may be taken during different terms. Instruction and practice in the written and oral presentation of experimental results provided. Modules and prerequisites are as follows:
—Module 10 (Prereq: 5.61, Module 6) Quantum Dots.
—Module 11 (Prereq: 5.61, 5.07 or 7.05, Module 5) Time Resolved Molecular Spectroscopy.
—Module 12 (Prereq: 5.61, 5.07 or 7.05, Module 6) Solid State NMR.

Enrollment limited; preference to Course 5 majors.

M. G. Bawendi (Module 10), A. Tokmakoff (Module 12), J. Simpson (Module 12)

5.43 Advanced Organic Chemistry
(Subject meets with 5.53)
Prereq: 5.13
U (Fall)
4-0-8
Credit cannot also be received for 5.53, 5.56

Reaction mechanisms in organic chemistry: methods of investigation, relation of structure to reactivity, and reactive intermediates. Organometallic chemistry, with an emphasis on fundamental reactivity, mechanistic studies, and applications in organic chemistry.

G. Fu

5.44 Organometallic Chemistry
Prereq: 5.43, 5.47, 5.061, or permission of instructor
G (Spring; second half of term)
3-0-6 H-LEVEL Grad Credit

Examination of the most important transformations of organotransition-metal species. Emphasizes basic mechanisms of their reactions, structure-reactivity relationships, and applications in synthesis.

S. Buchwald

5.451 Chemistry of Biomolecules and Natural Product Pathways
Prereq: 5.43
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit

Introduction to chemistry, biology, biochemistry and metabolic engineering of secondary metabolic pathways.

S. E. O’Connor

5.46 NMR Spectroscopy and Organic Structure Determination
Prereq: 5.43
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit

Applications of 1-D and 2-D $^1$H and $^{13}$C NMR spectroscopy to organic structure determination.

J. H. Simpson

5.47 Tutorial in Organic Chemistry
Prereq: 5.43, permission of instructor
G (Fall)
2-0-4 [P/D/F] H-LEVEL Grad Credit

Systematic review of basic principles concerned with the structure and transformations of organic molecules. Problem-solving workshop format. The program is intended primarily for first-year graduate students with a strong interest in organic chemistry. Meets during the month of September.

Staff

5.48j Protein Folding and Human Disease
(Subject meets with 7.88j, 10.543j)
Prereq: 7.51 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject 7.88j.

S. Lindquist, J. A. King

5.50 Enzymes: Structure and Function
Prereq: 5.07 or 7.05; 5.12, 5.13
G (Spring)
3-0-9 H-LEVEL Grad Credit

Introduction to methods used to elucidate the mechanism of enzyme-catalyzed reactions. Application of steady-state and presteady-state kinetics, isotope effect measurements, site-directed mutagenesis, and mechanism-based inhibitors as tools to investigate the mechanisms of enzymes that have been well-characterized structurally.

J. Stubbe
5.511 Synthetic Organic Chemistry I
Prereq: 5.43
G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to the design of syntheses of complex organic compounds.
R. L. Danheiser

5.512 Synthetic Organic Chemistry II
Prereq: 5.511
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
General methods and strategies for the synthesis of complex organic compounds.
T. F. Jamison

5.52 Advanced Biological Chemistry
Prereq: Permission of instructor
G (Fall)
2-2-8 H-LEVEL Grad Credit
Concepts and methods of biochemistry, with emphasis on quantitative aspects of problem analysis and fundamentals of experimental methods. Intended for first-year graduate students with a strong interest in biological chemistry.
A. M. Klibanov

5.53 Molecular Structure and Reactivity I
(Subject meets with 5.43)
Prereq: 5.13, 5.60
G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
Credit cannot also be received for 5.43, 5.56
Reaction mechanisms in organic chemistry: methods of investigation, relation of structure to reactivity, and reactive intermediates.
G. Fu

5.54A) Frontiers in Chemical Biology
(Same subject as 7.540J, 20.554J)
Prereq: 5.13, 5.07, 7.06, permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Introduction to current research at the interface of chemistry, biology, and bioengineering. Topics include imaging of biological processes, metabolic pathway engineering, protein engineering, mechanisms of DNA damage, RNA structure and function, macromolecular machines, protein misfolding and disease, metabolomics, and methods for analyzing signaling network dynamics. Lectures are interspersed with class discussions and student presentations based on current literature.
B. Imperiali, S. O’Connor

5.55 Chemical Tools for Assessing Biological Function
Prereq: 5.43; 5.07 or 7.05; Coreq: 5.47 or 5.52
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
2-0-4 H-LEVEL Grad Credit
Contemporary bioorganic chemistry and chemical biology, emphasizing the application of chemical approaches to interrogate biochemical function. Selected topics include specific enzyme inhibition as a mechanism for rational drug design; molecular mechanisms of drug resistance; uses of intrinsic and extrinsic reporter functionality to understand biological functions and interactions; chemical methods for probing cellular activities in real time. Meets with 20.485 for second half of term.
B. Imperiali, F. White

5.56 Molecular Structure and Reactivity II
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
2-0-4 H-LEVEL Grad Credit
Credit cannot also be received for 5.43, 5.53
Application of physical principles and methods to contemporary problems of interest in organic chemistry.
Staff

5.561 Chemistry in Industry
Prereq: 5.03; 5.07 or 7.05; 5.13
G (Spring; second half of term)
2-0-4 [P/D/F] H-LEVEL Grad Credit
Examination of recent advances in organic, biological, and inorganic and physical chemical research in industry. Taught in seminar format with participation by scientists from industrial research laboratories.
R. L. Danheiser

5.564 Biophysical Chemistry
Prereq: 5.13, 5.60; 5.07 or 7.05
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
2-0-4 H-LEVEL Grad Credit
Introduction to the major principles and concepts of biophysical chemistry, with emphasis on the thermodynamics and kinetics of macro-molecular reactions, including conformational changes and interactions with small molecules and other macromolecules.
Staff

5.565 Molecular Imaging
Prereq: 5.13, 5.60; 5.07 or 7.05
G (Fall; second half of term)
2-0-4 H-LEVEL Grad Credit
Overview of molecular imaging methods used to study biological systems, ranging from cells to entire organisms. Course begins with micrometer-scale imaging, dominated by visible light microscopy. Students discuss physics and instrumentation, chemical probes, and biological applications. The second unit covers imaging at millimeter scales, focusing on PET and MRI imaging in live organisms. The final unit addresses imaging at the nanometer to micrometer scale: electron microscopy, AFM, and NSOM.
A. Ting

5.56 Thermodynamics and Kinetics
Prereq: Calculus II (GIR), Chemistry (GIR)
U (Fall, Spring)
5-0-7 REST
Equilibrium properties of macroscopic systems. Basic thermodynamics: state of a system, state variables. Work, heat, first law of thermodynamics, thermochemistry. Second and third law of thermodynamics: entropy and free energy, including the molecular basis for these thermodynamic functions. Phase equilibrium and properties of solutions. Chemical equilibrium of reactions in gas and solution phases. Rates of chemical reactions. Special attention to thermodynamics related to global energy issues.
Fall: A. Tokmakoff, R. J. Silbey
Spring: M. G. Bawendi, R. J. Silbey

5.61 Physical Chemistry
Prereq: Physics II (GIR), Calculus II (GIR), Chemistry (GIR)
U (Fall)
5-0-7 REST
Introductory quantum chemistry; particles and waves; wave mechanics; atomic structure and the Periodic Table; valence and molecular orbital theory; molecular structure; and photochemistry.
R. W. Field, T. Van Voorhis

5.62 Physical Chemistry
Prereq: 5.60, 5.61
U (Spring)
4-0-8
Elementary statistical mechanics; transport properties; kinetic theory; solid state; reaction rate theory; and chemical reaction dynamics.
K. A. Nelson, R. W. Field

5.63 Physical Chemistry
Prereq: 5.13, 5.60; 5.07 or 7.05
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
2-0-4 H-LEVEL Grad Credit
Introduction to the major principles and concepts of biophysical chemistry, with emphasis on the thermodynamics and kinetics of macro-molecular reactions, including conformational changes and interactions with small molecules and other macromolecules.
Staff

5.64 Molecular Imaging
Prereq: 5.13, 5.60; 5.07 or 7.05
G (Fall; second half of term)
2-0-4 H-LEVEL Grad Credit
Overview of molecular imaging methods used to study biological systems, ranging from cells to entire organisms. Course begins with micrometer-scale imaging, dominated by visible light microscopy. Students discuss physics and instrumentation, chemical probes, and biological applications. The second unit covers imaging at millimeter scales, focusing on PET and MRI imaging in live organisms. The final unit addresses imaging at the nanometer to micrometer scale: electron microscopy, AFM, and NSOM.
A. Ting
5.675J Computational Quantum Mechanics of Molecular and Extended Systems
(Same subject as 10.675J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject 10.675J.
B. L. Trout

5.68J Kinetics of Chemical Reactions
(Same subject as 10.652J)
Prereq: 5.62, 10.37, or 10.65
G (Spring)
3-0-6 H-LEVEL Grad Credit
Experimental and theoretical aspects of chemical reaction kinetics, including transition-state theories, molecular beam scattering, classical techniques, quantum and statistical mechanical estimation of rate constants, pressure-dependence and chemical activation, modeling complex reacting mixtures, and uncertainty/sensitivity analyses. Reactions in the gas phase, liquid phase, and on surfaces are discussed with examples drawn from atmospheric, combustion, industrial, catalytic, and biological chemistry.
W. H. Green

5.70J Statistical Thermodynamics
(Same subject as 10.546J)
Prereq: 5.60 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Develops classical equilibrium statistical mechanical concepts for application to chemical physics problems. Basic concepts of ensemble theory formulated on the basis of thermodynamic fluctuations. Examples of applications include Ising models, lattice models of binding, ionic and non-ionic solutions, liquid theory, polymer and protein conformations, phase transition, and pattern formation. Introduces computational techniques with examples of liquid and polymer simulations.
J. Cao

5.72 Statistical Mechanics
Prereq: 5.70, 5.73, 18.075
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit
J. Cao

5.73 Introductory Quantum Mechanics I
Prereq: 5.61, 8.03, 18.03
G (Fall)
2-0-4 H-LEVEL Grad Credit
Fundamental concepts of quantum mechanics: wave properties, uncertainty principles, Schrodinger equation, and operator and matrix methods. Basic applications to: one-dimensional potentials (harmonic oscillator), three-dimensional centrosymmetric potentials (hydrogen atom), and angular momentum and spin. Approximation methods: WKB method, variational principle, and perturbation theory.
R. G. Griffin

5.74 Introductory Quantum Mechanics II
Prereq: 5.73
G (Spring)
3-0-9 H-LEVEL Grad Credit
Time-dependent quantum mechanics and spectroscopy. Topics include perturbation theory, two-level systems, light-matter interactions, relaxation in quantum systems, correlation functions and linear response theory, and nonlinear spectroscopy.
A. Tokmakoff, T. Van Voorhis

5.77J Topics in Metabolic Biochemistry
(Same subject as 7.75J)
Subject meets with 7.35
Prereq: 7.05 or 5.07
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 7.75J.
G. M. Brown

5.78 Biophysical Chemistry Techniques
(Subject meets with 7.71)
Prereq: 5.07 or 7.05
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
Presents principles of macromolecular crystallography that are essential for structure determinations. Topics include crystallization, diffraction theory, symmetry and space groups, data collection, phase determination methods, model building, and refinement. Discussion of crystallography theory complemented with exercises such as crystallization, data processing, and model building. Enrollment limited.
C. Drennan, T. Schwartz

5.80 Advanced Topics of Current Special Interest
Prereq: 5.61 or 8.04; 18.03
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Advanced topics of current special interest.
Staff

5.891 Special Topics in Chemistry for Undergraduates
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

5.892 Special Topics in Chemistry for Undergraduates
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Program of study to be arranged by the student and a departmental faculty member.
Staff

5.90 Special Problems in Chemistry
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Directed research and study of special chemical problems. For graduate students only.
R. W. Field

5.913 Seminar in Organic Chemistry
Prereq: Permission of instructor
G (Fall)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

5.914 Seminar in Organic Chemistry
Prereq: Permission of instructor
G (Spring)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Discussion of current journal publications in organic chemistry by graduate students and staff members.
R. L. Danheiser

5.92 Energy in the Local Community
Prereq: Permission of instructor
U (Spring)
4-2-6
Explores energy issues and community dynamics at the local level: on the MIT campus and in the cities of Cambridge and Boston. Staff in the Laboratory for Energy and the Environment work with community contacts to develop project
ideas of concern to community leaders that have potential to affect local energy management. Students are involved in all aspects of project design, from the refinement of research questions to conclusions and presentation of findings. Includes exercises in written and oral communication and team building. Enrollment limited; preference to freshmen.

J. I. Steinfeld

5.921 Seminar in Biological Chemistry
Prereq: Permission of instructor
G (Fall)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
5.922 Seminar in Biological Chemistry
Prereq: Permission of instructor
G (Spring)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Discusses topics of current interest in biological chemistry by graduate students and staff.

A. Ting

5.931 Seminar in Physical Chemistry
Prereq: 5.60
G (Fall)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
5.932 Seminar in Physical Chemistry
Prereq: None
G (Spring)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Discusses topics of current interest in physical chemistry by staff members and students.

J. Cao

5.941 Seminar in Inorganic Chemistry
Prereq: 5.03
G (Fall)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
5.942 Seminar in Inorganic Chemistry
Prereq: 5.03
G (Spring)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Discusses current research in inorganic chemistry by graduate students and staff.

J. Peters

5.95J Teaching College-Level Science and Engineering
(Same subject as 6.982J, 7.59J, 8.395J, 18.094J)
Prereq: None
G (Spring)
2-0-2 [P/D/F]

Participatory seminar focuses on the knowledge and skills necessary for teaching science and engineering in higher education. Topics include: theories of adult learning; course development; promoting active learning, problem solving, and critical thinking in students; communicating with a diverse student body; using educational technology to further learning; lecturing; creating effective tests and assignments; and assessment and evaluation. Students research and present a relevant topic of particular interest. Subject is appropriate for both novices and those with teaching experience.

L. Breslow

5.CME Study at Cambridge University
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit

Provides credit for students studying at Cambridge University under the Cambridge-MIT Exchange program. Credit may be used to satisfy specific SB degree requirements. Consult with department and CME office.

S. T. Ceyer

5.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Program of research leading to the writing of a PhD thesis; to be arranged by the student and an appropriate MIT faculty member.

R. W. Field

5.THU Undergraduate Thesis
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Program of original research under supervision of a chemistry faculty member, culminating with the preparation of a thesis. Ordinarily requires equivalent of two terms of research with chemistry department faculty member.

S. T. Ceyer
Bachelor of Science in Chemistry/Course 5

**General Institute Requirements (GIRs)**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement (one subject can be satisfied by 5.111 or 5.112 in the Departmental Program)</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement (one subject can be satisfied by 5.12, 5.60, or 5.61 in the Departmental Program)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (can be satisfied by completing all three modules in 5.35 in the Departmental Program)</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Total GIR Subjects Required for SB Degree: 17

**Communication Requirement**

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

**Required Subjects**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.03 Principles of Inorganic Chemistry I, 12</td>
<td>12</td>
</tr>
<tr>
<td>5.07 Biological Chemistry I, 12</td>
<td>12</td>
</tr>
<tr>
<td>5.111 or 5.112 Principles of Chemical Science, (1) 12</td>
<td></td>
</tr>
<tr>
<td>5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)</td>
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<tr>
<td>5.13 Organic Chemistry II, 12, 5.12</td>
<td></td>
</tr>
<tr>
<td>5.35 Introduction to Experimental Chemistry, 12, LAB; Chemistry (GIR)</td>
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</tr>
<tr>
<td>Module 1 Survey of Spectroscopy, 4</td>
<td></td>
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<tr>
<td>Module 2 Inorganic Synthesis and Kinetics, 4, Module 1</td>
<td></td>
</tr>
<tr>
<td>Module 3 Polymeric Light Emitting Devices, 4, 5.12, Module 2</td>
<td></td>
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<tr>
<td>5.16 Biochemistry and Organic Laboratory, 12, CI-M</td>
<td></td>
</tr>
<tr>
<td>Module 4 Expression and Purification of Enzyme Mutants, 4, 5.07 or 7.05; Module 2 or 5.310; Module 5</td>
<td></td>
</tr>
<tr>
<td>Module 5 Kinetics of Enzyme Inhibition, 4, 5.07 or 7.05; Module 2 or 5.310; Module 4</td>
<td></td>
</tr>
<tr>
<td>Module 6 Organic Structure Determination, 4, 5.12; Module 2 or 5.310; 5.13</td>
<td></td>
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<tr>
<td>5.17 Organic and Inorganic Laboratory, 12</td>
<td></td>
</tr>
<tr>
<td>Module 7 Introduction to Organic Synthesis, 4, 5.13, Module 6</td>
<td></td>
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<tr>
<td>Module 8 Two-Electron Bond, 4, 5.03, Module 6, 5.61</td>
<td></td>
</tr>
<tr>
<td>Module 9 Dinitrogen Cleavage, 4, 5.03, Module 6, 5.61</td>
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</tr>
<tr>
<td>5.18 Physical Chemistry Laboratory, 12, CI-M</td>
<td></td>
</tr>
<tr>
<td>Module 10 Quantum Dots, 4, 5.61, Module 6</td>
<td></td>
</tr>
<tr>
<td>Module 11 Time Resolved Molecular Spectroscopy, 4, 5.61, 7.05 or 5.310; Module 5</td>
<td></td>
</tr>
<tr>
<td>Module 12 Solid State NMR, 4, 5.61, 7.05 or 5.310; Module 6</td>
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</tr>
<tr>
<td>5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)</td>
<td></td>
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<tr>
<td>5.61 Physical Chemistry, 12, REST; Physics II (GIR), Calculus II (GIR), Chemistry (GIR)</td>
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</tbody>
</table>

**Restricted Electives**

At least two of the following four subjects:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.04 Principles of Inorganic Chemistry II, 12</td>
<td>12</td>
</tr>
<tr>
<td>5.08I Biological Chemistry II, 12</td>
<td>12</td>
</tr>
<tr>
<td>5.07I Advanced Organic Chemistry, 12</td>
<td>12</td>
</tr>
<tr>
<td>5.62 Physical Chemistry, 12</td>
<td>12</td>
</tr>
</tbody>
</table>

**Departmental Program Units That Also Satisfy the GIRs**

(36)(2)

**Unrestricted Electives**

(60)

Total Units Beyond the GIRs Required for SB Degree: 180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student's departmental program will count toward one or the other, but not both.

**Notes**

(1) An alternate subject is listed in the GIR description.

(2) Students who do not take 5.111 or 5.112 to fulfill the General Institute Requirement in Chemistry will have 24 units in the Departmental Program that will also satisfy the General Institute Requirements.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
**Basic Undergraduate Subjects**

6.00 Introduction to Computer Science and Programming
Prereq: None
U (Fall, Spring) 3-7-2 REST

Introduction to computer science and programming for students with little or no programming experience. Students learn how to program and how to use computational techniques to solve problems. Topics include algorithms, simulation techniques, and use of software libraries. Assignments are done using the Python programming language.

J. V. Guttag

6.01 Introduction to EECS I
Prereq: None. Coreq: Physics II (GIR)
U (Fall) 2-4-6 1/2 Institute LAB

An integrated introduction to electrical engineering and computer science, taught using substantial laboratory experiments with mobile robots. Key issues in the design of engineered artifacts operating in the natural world: measuring and modeling system behaviors; assessing errors in sensors and effectors; specifying tasks; designing solutions based on analytical and computational models; planning, executing, and evaluating experimental tests of performance; refining models and designs. Issues addressed in the context of computer programs, control systems, probabilistic inference problems, circuits and transducers, which all play important roles in achieving robust operation of a large variety of engineered systems. 6 Engineering Design Points.

H. Abelson, L. P. Kaelbling, J. K. White

6.02 Introduction to EECS II
Prereq: 6.01; 18.03 or 18.06
U (Fall, Spring) 3-3-6 1/2 Institute LAB

An integrated introduction to electrical engineering and computer science, taught using substantial laboratory experiments that explore communication signals, systems and networks. Physical characterization and modeling of transmission systems in the time and frequency domains; analog and digital signaling; coding; detecting and correcting errors; relating information transmission rate to signal power, bandwidth and noise; engineering of packet-switched networks. These explorations are used to illustrate the role of abstraction and modularity in engineering design; building reliable systems using imperfect components; selecting appropriate design metrics; choosing effective representations for information; analyzing the performance and correctness of algorithms; and tradeoffs in complex systems. 6 Engineering Design Points.

A. Agarwal, J. del Alamo, J. H. Lang, D. J. Perreault

6.03 Signals and Systems
Prereq: 6.002 or 6.02
U (Fall, Spring) 5-0-7

Fundamentals of signal and system analysis, with applications drawn from filtering, audio and image processing, communications, and automatic control. Topics include convolution, Fourier series and transforms, sampling and discrete-time processing of continuous-time signals, modulation, Laplace and Z-transforms, and feedback systems. 4 Engineering Design Points.

D. M. Freeman, Q. Hu, J. S. Lim

6.04 Computation Structures
Prereq: 6.001, 6.002; or 6.02
U (Fall, Spring) 4-0-8

Introduces architecture of digital systems, emphasizing structural principles common to a wide range of technologies. Multilevel implementation strategies; definition of new primitives (e.g., gates, instructions, procedures, and processes) and their mechanization using lower-level elements. Analysis of potential concurrency; precedence constraints and performance measures; pipelined and multidimensional systems. Instruction set design issues; architectural support for contemporary software structures. 4 Engineering Design Points.

S. A. Ward, C. J. Terman

6.07 Projects in Microscale Engineering for the Life Sciences
(Same subject as HST.410J)
Prereq: None
U (Spring) 2-4-3

See description under subject HST.410J.

D. Freeman, M. Gray, A. Aranyosi

6.002 Circuits and Electronics
Prereq: 18.03; Physics II (GIR) or 6.01
U (Fall, Spring) 4-1-7 REST

Fundamentals of the lumped circuit abstraction. Resistive elements and networks, independent and dependent sources, switches and MOS devices, digital abstraction, amplifiers, and energy storage elements. Dynamics of first- and second-order networks; design in the time and frequency domains; analog and digital circuits and applications. Design exercises. Occasional laboratory. 4 Engineering Design Points.

A. Agarwal, J. del Alamo, J. H. Lang, D. J. Perreault

6.006 Introduction to Algorithms
Prereq: 6.01, 6.042?
U (Fall, Spring) 4-0-8

Introduction to mathematical modeling of computational problems, as well as common algorithms, algorithmic paradigms, and data
structures used to solve these problems. Emphasizes the relationship between algorithms and programming, and introduces basic performance measures and analysis techniques for these problems.

R. L. Rivest, S. Devadas

6.007 Electromagnetic Energy: From Motors to Lasers
Prereq: 6.01, 18.03
U (Fall, Spring)
4-1-7
Applications of electromagnetic principles to classical and modern devices. Basic electrical components, electric motors and generators, power flow, and energy conversion in macroscopic to quantum-scale electrical and electromechanical systems. Photons and their interaction with matter in detectors, sources, optical fibers, and other devices and communication systems.

V. Bulovic, R. J. Ram

6.011 Introduction to Communication, Control, and Signal Processing
Prereq: 6.003; 6.041 or 18.440
U (Spring)
4-0-8
Signals, systems and inference as unifying themes in communication, control and signal processing. Input-output and state-space models of linear systems driven by deterministic and random signals; time- and transform-domain representations in discrete and continuous time. State feedback and observers. Probabilistic models; stochastic processes, correlation functions, power spectra, spectral factorization. Least-mean square error estimation; Wiener filtering. Detection; matched filters.

A. V. Oppenheim, G. C. Verghese

6.012 Microelectronic Devices and Circuits
Prereq: 6.002
U (Fall, Spring)
4-0-8
Microelectronic device modeling, and basic microelectronic circuit analysis and design. Physical electronics of semiconductor junction and MOS devices. Relating terminal behavior to internal physical processes, developing circuit models, and understanding the uses and limitations of different models. Use of incremental and large-signal techniques to analyze and design transistor circuits, with examples chosen from digital circuits, linear amplifiers, and other integrated circuits. Design project. 4 Engineering Design Points.

A. I. Akinwande, D. A. Antoniadis, C. G. Fonstad, Jr., C. G. Sodini

6.013 Electromagnetics and Applications
(Subject meets with 6.630)
Prereq: 6.003 or 6.007
U (Fall, Spring)
4-0-8
Explores electromagnetic phenomena in modern applications, including wireless and optical communications, circuits, computer interconnects and peripherals, microwave communications and radar, antennas, sensors, micro-electromechanical systems, and power generation and transmission. Fundamentals include quasistatic and dynamic solutions to Maxwell’s equations; waves, radiation, and diffraction; coupling to media and structures; guided waves; resonance; acoustic analogs; and forces, power, and energy. Students taking graduate version complete different assignments. Meets with 6.630 in fall term only.

D. H. Staelin, E. P. Ippen, M. Zahn

6.021J Cellular Biophysics
(Same subject as 2.791J, 20.370J)
Prereq: 2.794J, 6.521J, 20.470J, HST.541J
U (Spring)
4-0-8
Integrated overview of the biophysics of cells from prokaryotes to neurons, with a focus on mass transport and electrical signal generation across cell membrane. First half of course focuses on mass transport through membranes: diffusion, osmosis, chemically mediated, and active transport. Second half focuses on electrical properties of cells: ion transport to action potentials in electrically excitable cells. Electrical properties interpreted via kinetic and molecular properties of single voltage-gated ion channels. Laboratory and computer exercises illustrate the concepts. Provides instruction in written and oral communication. Students taking graduate version complete different assignments. Preference to juniors and seniors. 4 Engineering Design Points.

D. M. Freeman, J. Han, J. Volman

6.022J Quantitative Systems Physiology
(Same subject as 2.792J, 20.371J, HST.542J)
Prereq: Physics II (GIR), 18.03, or permission of instructor
U (Spring)
4-2-6
Application of the principles of energy and mass flow to major human organ systems. Mechanisms of regulation and homeostasis. Anatomical, physiological and pathophysiological features of the cardiovascular, respiratory and renal systems. Systems, features and devices that are most illuminated by the methods of physical sciences. Laboratory work includes some animal studies. 2 Engineering Design Points.

R. G. Mark, C. M. Stultz

6.023J Fields, Forces and Flows in Biological Systems
(Same subject as 2.793J, 20.330J)
Prereq: 2.005, 6.021, 20.320 or permission of instructor
U (Spring)
4-0-8
See description under subject 20.330J.
J. Han, L. Griffith

6.024J Molecular, Cellular, and Tissue Biomechanics
(Same subject as 2.797J, 3.053J, 20.310J)
Prereq: 2.370 or 2.772J; 18.03 or 3.016; Biology (GIR)
U (Spring)
4-0-8
See description under subject 2.797J.
R. D. Kamm

6.033 Computer System Engineering
Prereq: 6.004
U (Spring)
5-0-7
Topics on the engineering of computer software and hardware systems: techniques for controlling complexity; strong modularity using client-server design, operating systems; performance, networks; naming; security and privacy; fault-tolerant systems, atomicity and coordination of concurrent activities, and recovery; impact of computer systems on society. Case studies of working systems and readings from the current literature provide comparisons and contrasts. Two design projects. Students engage in extensive written communication exercises. Enrollment may be limited. 4 Engineering Design Points.

M. F. Kaashoek, H. Balakrishnan

6.034J Artificial Intelligence
(Subject meets with HST.947)
Prereq: 6.001 or 6.01
U (Fall, Spring)
5-3-4
Introduces representations, techniques, and architectures used to build applied systems and to account for intelligence from a computational point of view. Applications of rule chaining, heuristic search, constraint propagation, con-

P. H. Winston

6.035 Computer Language Engineering
Prereq: 6.005 or 6.170
U (Spring)
4-4-4
Analyzes issues associated with the implementation of higher-level programming languages. Fundamental concepts, functions, and structures of compilers. The interaction of theory and practice. Using tools in building software. Includes a multi-person project on compiler design and implementation. 8 Engineering Design Points.

S. P. Amarasinghe

6.041 Probabilistic Systems Analysis
(Subject meets with 6.431)
Prereq: Calculus II (GIR)
U (Fall, Spring)
4-0-8 REST
Credit cannot also be received for 18.05

D. P. Bertsekas, J. N. Tsitsiklis

6.042 Mathematics for Computer Science
(Same subject as 18.062)
Prereq: Calculus I (GIR)
U (Fall, Spring)
5-0-7 REST
Elementary discrete mathematics for computer science and engineering. Emphasis on mathematical definitions and proofs as well as on applicable methods. Topics: formal logic notation, proof methods; induction, well-ordering; sets, relations; elementary graph theory; integer congruences; asymptotic notation and growth of functions; permutations and combinations, counting principles; discrete probability. Further selected topics such as: recursive definition and structural induction; state machines and invariants; recurrences; generating functions.

A. R. Meyer, T. Leighton

6.045 Automata, Computability, and Complexity
(Same subject as 18.400)
Prereq: 6.042
U (Spring)
4-0-8

S. Micali

6.046 Design and Analysis of Algorithms
(Same subject as 18.410)
Prereq: 6.006 (alternatively: 6.001; 6.042/18.062 or 18.310)
U (Fall)
4-0-8
Techniques for the design and analysis of efficient algorithms, emphasizing methods useful in practice. Topics include sorting; search trees, heaps, and hashing; divide-and-conquer; dynamic programming; greedy algorithms; amortized analysis; graph algorithms; and shortest paths. Advanced topics may include network flow; computational geometry; number-theoretic algorithms; polynomial and matrix calculations; caching; and parallel computing.

C. E. Leiserson, M. Goemans

6.047 Computational Biology: Genomes, Networks, Evolution
(Subject meets with 6.878, HST.507)
Prereq: 6.006, 6.041, and Biology (GIR); or permission of instructor
U (Fall)
3-0-9
Covers the algorithmic and machine learning foundations of computational biology, combining theory with practice. Principles of algorithm design, influential problems and techniques, and analysis of large-scale biological datasets. Topics include (a) genomes: sequence analysis, gene finding, RNA folding, genome alignment and assembly, database search; (b) networks: gene expression analysis, regulatory motifs, biological network analysis; (c) evolution: comparative genomics, phylogenetics, genome duplication, genome rearrangements, evolutionary theory. These are covered with fundamental algorithmic techniques including: dynamic programming, hashing, Gibbs sampling, expectation maximization, hidden Markov models, stochastic context-free grammars, graph clustering, dimensionality reduction, Bayesian networks.

M. Kellis

6.048 Computational Evolutionary Biology (New)
(Subject meets with 6.877, HST.949)
Prereq: 6.047 or permission of instructor
U (Fall)
3-3-6
Explores and illustrates theory underlying computational approaches to solving problems in evolutionary biology. Begins with components of evolutionary theory and inferential logic of evolution by natural selection. Emphasizes development of analytical skills needed to judge the computational and algorithmic implications and requirements of evolutionary models. Examples drawn from current research in evolutionary biology: whole-genome species comparison, phylogenetic tree construction, molecular evolution, homology and development, optimization and evolvability, heritability, disease evolution, detecting selection in human populations, and evolution of language. Extensive laboratory exercises in model-building and analyzing evolutionary data. Graduate version requires a more substantial final project and completion of additional laboratory assignments. 4 Engineering Design Points.

R. C. Berwick

6.050 Information, Entropy and Computation
(Same subject as 2.110)
Prereq: Physics I (GIR)
U (Spring)
4-0-5
Explores the ultimate limits to communication and computation, with an emphasis on the physical nature of information and information processing. Topics include information and computation, digital signals, codes, and compression. Biological representations of information. Logic circuits, computer architectures, and algorithmic information. Noise, probability, and error correction. The concept of entropy applied to channel capacity and to the second law of thermodynamics. Reversible and irreversible operations and the physics of computation. Quantum computation.

P. Penfield, Jr., S. Lloyd

6.055J The Art of Approximation in Science and Engineering
(Same subject as 2.038)
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
3-0-9
Simple reasoning techniques for complex phenomena: divide and conquer, dimensional analysis, extreme cases, continuity, scaling, successive approximation, balancing, cheap calculus, and symmetry. Applications from physical and biological sciences, mathematics,
and engineering. Examples include bird and machine flight, neuron biophysics, weather, prime numbers, and animal locomotion. Emphasis on low-cost experiments to test ideas and on fostering curiosity about phenomena in the world. S. Mahajan, R. Abeyaratne

6.061 Introduction to Electric Power Systems
(Subject meets with 6.690)
Prereq: 6.002, 6.013
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9
Electric circuit theory with application to power handling electric circuits. Modeling and behavior of electromechanical devices, including magnetic circuits, motors and generators. Operational fundamentals of synchronous, induction and DC machinery. Interconnection of generators and motors with electric power transmission and distribution circuits. Power generation, including alternative and sustainable sources. 6 Engineering Design Points.
J. L. Kirtley, Jr.

6.070] Electronics Project Laboratory
(Same subject as SP.705J)
Prereq: None
U (Fall, Spring)
2-2-2
Introduction to electronics test equipment such as oscilloscopes, meters (voltage, resistance inductance, capacitance, etc.), and signal generators. Emphasizes individual instruction and development of skills, such as soldering, assembly, and troubleshooting. Students build and keep an electronics kit, such as a radio, to serve as the vehicle for learning about electronics test and measurement equipment. Intended for students without a previous background in electronics. Enrollment may be limited.
J. Boles

6.071] Electronics, Signals, and Measurement
(Same subject as 22.071J)
Prereq: 18.03
U (Spring)
3-3-6 REST
Provides the knowledge necessary for reading schematics and designing, building, analyzing, and testing fundamental analog and digital circuits. Students construct interactive examples and explore the practical uses of electronics in engineering and experimental science, including signals and measurement fundamentals. Uses state-of-the-art hardware and software for data acquisition, analysis, and control. Suitable for students with little or no previous background in electronics.
I. Hutchinson

6.072] Introduction to Digital Electronics
(Same subject as SP.702J)
Prereq: None
U (Spring)
0-3-3 [P/D/F]
See description under subject SP.702J.
J. Boles

6.076–6.079 Special Subjects in Electrical Engineering and Computer Science (New)
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
6.080–6.089 Special Subjects in Electrical Engineering and Computer Science
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
6.090–6.099 Special Subjects in Electrical Engineering and Computer Science
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

UNDERGRADUATE LABORATORY SUBJECTS

6.100 Electrical Engineering and Computer Science Laboratory
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Individual experimental work related to electrical engineering and computer science not covered by other subjects. Student must make arrangements with a project supervisor and file a proposal endorsed by the supervisor. Departmental approval required. Written report to be submitted upon completion of work. If 6.100 is used to satisfy departmental laboratory requirement, student must register for 12 units of laboratory credit in the term the work is done. Consult department undergraduate office early in the term.
C. J. Terman

6.101 Introductory Analog Electronics Laboratory
Prereq: 6.002 or 6.071
U (Fall)
2-9-1 Institute LAB
Introductory experimental laboratory explores the design, construction, and debugging of analog electronic circuits. Lectures and six laboratory projects investigate the performance characteristics of diodes, transistors, JFETs, and op-amps, including the construction of a small audio amplifier and preamplifier. Seven weeks are devoted to the design and implementation, and written and oral presentation of a project in an environment similar to that of engineering design teams in industry. Provides opportunity to simulate real-world problems and solutions that involve trade offs and the use of engineering judgment. Engineers from local analog engineering companies come to campus to help students with their design projects. 12 Engineering Design Points.
B. M. Roscoe

6.102 Introductory RF Design Laboratory
Prereq: 6.002 or 6.071
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
2-9-1 Institute LAB
Introductory experimental laboratory focuses on the fundamentals of radio frequency design through the study of radio receiver circuits from 1920 to 1960. Five labs using JFETs (arranged to behave like triodes and pentodes) investigate the behavior of series and parallel tuned circuits, bandwidth control, RF amplifiers, local oscillators, mixers, IF amplifiers, AM and FM detectors, audio stages, and RF measurements. Lecture topics include regenerative receivers and detectors; tuned RF, nearedyne, superhet- erodyne and FM receivers; the “All-American 5” AC-DC AM receiver; and common vacuum tube triode and pentode topologies. Five weeks of the term are devoted to the restoration and circuit analysis of an antique radio supplied by the instructor. 12 Engineering Design Points.
B. M. Roscoe

6.111 Introductory Digital Systems Laboratory
Prereq: 6.002, 6.071, or 16.004
U (Fall, Spring)
3-7-2 Institute LAB
Lectures and labs on digital logic, flip flops, PALs, FPGAs, counters, timing, synchronization, and finite-state machines prepare students for the design and implementation of a final project of their choice: games, music, digital filters, wireless communications, video, or graphics. Extensive use of Verilog for describing and
implementing digital logic designs. Students engage in extensive written and oral communication exercises. 12 Engineering Design Points. A. P. Chandrakasan, C. J. Terman, A. I. Akinwande

6.115 Microcomputer Project Laboratory
Prereq: 6.002, 6.003, 6.004, or 6.007
U (Spring)
3-6-3 Institute LAB
Introduces the analysis and design of embedded systems. Microcontrollers provide adaptation, flexibility, and real-time control. Emphasis placed on the construction of complete systems, including a five-axis robot arm, a fluorescent lamp ballast, a tomographic imaging station (e.g. a CAT scan), and a simple calculator. Introduces a wide range of basic tools, including software and development tools, peripheral components such as A/D converters, communication schemes, signal processing techniques, closed-loop digital feedback control, interface and power electronics, and modeling of electromechanical systems. Includes a sequence of assigned projects, followed by a final project of the student's choice, emphasizing creativity and uniqueness. Final project may be expanded to satisfy a 6.UAP project. Provides instruction in written and oral communication. 12 Engineering Design Points.
S. B. Leeb

6.121J Bioelectronics Project Laboratory
(Same subject as HST.575J)
Prereq: 6.002 or 6.071
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
2-8-2 Institute LAB
Project laboratory in electronic instrumentation, interfacing the analog and digital world. Students specify design, implement, and evaluate biomedical instruments, including several interconnected analog and digital subsystems. Extensive use of integrated analog circuits and a microprocessor. Classroom development of analytic models for complex functional components and the measurement process in the context of a longitudinal laboratory project. Students engage in extensive written and oral communication exercises. 12 Engineering Design Points.
D. M. Freeman, M. F. Yanik

6.122J Instrumentation and Measurement for Biological Systems (New)
(Same subject as 2.673J, 20.309J, MAS.402J)
Prereq: Biology (GIR), Physics II (GIR), 6.00, 18.03; 2.001, 20.310, or 6.02; or permission of instructor; Coreq: 20.330
U (Fall, Spring)
3-6-3
See description under subject 20.309.
Fall: S. Manalis, P. T. So, S. Wasserman
Spring: E. Boyden, S. Wasserman, M. F. Yanik

6.131 Power Electronics Laboratory
Prereq: 6.002, 6.003, or 6.007
U (Fall)
3-6-3 Institute LAB
Introduces the design and construction of power electronic circuits and motor drives. Laboratory exercises include the construction of drive circuitry for an electric go-cart, flash strobes, computer power supplies, three-phase inverters for AC motors, and resonant drives for lamp ballasts and induction heating. Basic electric machines introduced include DC, induction, and permanent magnet motors, with drive considerations. Final project may be expanded to serve as a 6.UAP project, with instructor permission. Provides instruction in written and oral communication. 12 Engineering Design Points.
S. B. Leeb, J. L. Kirtley, Jr.

6.141J Robotics: Science and Systems I
(Same subject as 16.405J)
Prereq: Permission of instructor
U (Spring)
2-6-4 Institute LAB
Presents concepts, principles, and algorithms for computation related to the physical world. Topics covered are: motion planning, geometric reasoning, kinematics and dynamics, state estimation, tracking, map building, manipulation, human-robot interaction, fault diagnosis, and embedded system development. Students specify and design a small-scale yet complex robot capable of real-time interaction with the natural world. Students may continue coursework in 6.142. Prior knowledge of one or more of the following areas would be useful: control (2.004, 6.302, or 16.30); software (1.00, 6.005, or 16.35); electronics (6.002, 6.070, 6.111, or 6.115); mechanical engineering (2.007); or independent experience such as MasLAB, 6.270, or a UROP. 12 Engineering Design Points.
N. Roy, D. Rus, S. Teller

6.142J Robotics: Science and Systems II
(Subject meets with 16.406J)
Prereq: 6.141 or permission of instructor
U (Fall)
2-6-4
Implementation and operation of the embedded system designed in 6.141. Addresses open research issues such as sustained autonomy, situational awareness, and human interaction. Students carry out experiments to assess their design and deliver a final written report. Prior knowledge of one or more of the following areas would be useful: control (2.004, 6.302, or 16.30), software (1.00, 6.005, or 16.35), electronics (6.002, 6.070, 6.111, or 6.115), mechanical engineering (2.007), independent experience (MasLAB, 6.270, or a UROP). 12 Engineering Design Points.
D. Rus, S. Teller, N. Roy

6.152J Micro/Nano Processing Technology
(Subject meets with 3.155J)
Prereq: Permission of instructor
U (Fall, Spring)
3-4-5
Introduces the theory and technology of micro/nano fabrication. Lectures and laboratory sessions on basic processing techniques such as vacuum processes, lithography, diffusion, oxidation, and pattern transfer. Students fabricate MOS capacitors, nanomechanical cantilevers, and microfluidic mixers. Emphasis on the inter-relationships between material properties and processing, device structure, and the electrical, mechanical, optical, chemical or biological behavior of devices. Provides background for thesis work in micro/nano fabrication. Students engage in extensive written and oral communication exercises. 6 Engineering Design Points.

6.161 Modern Optics Project Laboratory
(Subject meets with 6.637)
Prereq: 6.003
U (Fall)
3-5-4 Institute LAB
Lectures, laboratory exercises and projects on optical signal generation, transmission, detection, storage, processing and display. Topics include polarization properties of light; reflection and refraction; coherence and interference; Fraunhofer and Fresnel diffraction; holography; Fourier optics; coherent and incoherent imaging and signal processing systems; optical properties of materials; lasers and LEDs; electro-optic and acousto-optic light modulators; photorefractive and liquid-crystal light modulation; display technologies; optical waveguides and fiber-optic...
communication systems; photodetectors. Students may use this subject to find an advanced undergraduate project. Students engage in extensive oral and written communication exercises. Recommended prerequisites: 6.007 or 8.03. 12 Engineering Design Points.

C. Worde

6.163 Strobe Project Laboratory
Prereq: Physics II (GIR) or permission of instructor
U (Fall, Spring)
2-8-2 Institute LAB
Application of electronic flash sources to measurement and photography. First half covers fundamentals of photography and electronic flashes, including experiments on application of electronic flash to photography, stroboscopy, motion analysis, and high-speed videography. Students write five extensive lab reports. In the second half, students work in small groups to select, design, and execute independent projects in measurement or photography that apply learned techniques. Project planning and execution skills are discussed and developed over the term. Enrollment limited. 12 Engineering Design Points.

J. K. Vandiver, J. W. Bales

6.172 Performance Engineering of Software Systems (New)
Prereq: 6.004, 6.005, or 6.006
U (Fall)
3-6-3
Project-based introduction to building efficient, high-performance and scalable software systems. Topics include performance analysis, algorithmic techniques for high performance, instruction-level optimizations, cache and memory hierarchy optimization, parallel programming, and building scalable distributed systems. 12 Engineering Design Points.

S. Amarasinghe

6.182 Psychoacoustics Project Laboratory
Prereq: None
U (Spring)
3-6-3 Institute LAB
Introduces the methods used to measure human auditory abilities. Discusses auditory function, principles of psychoacoustic measurement, models for psychoacoustic performance, and experimental techniques. Project topics: absolute and differential auditory sensitivity, operating characteristics of human observers, span of absolute judgment, adaptive measurement procedures, and scaling sensory magnitudes. Knowledge of probability helpful. Students engage in extensive written and oral communication exercises. 12 Engineering Design Points.

L. D. Braida

6.183–6.190 Special Laboratory Subjects in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Can be repeated for credit
6.193–6.197 Special Laboratory Subjects in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Can be repeated for credit
Laboratory subjects not offered in the regular curriculum. Consult department to learn offerings for a particular term.

D. M. Freeman

SENIOR PROJECTS

6.1AT Undergraduate Advanced Project
Prereq: 6.1AT
U (Fall, Spring, Summer)
0-6-0
Can be repeated for credit
Research project for those students completing the SB degree, to be arranged by the student and an appropriate MIT faculty member. Students who register for this subject must consult the department undergraduate office. Students engage in extensive written communications exercises.

C. J. Terman

6.1AT Preparation for Undergraduate Advanced Project
Prereq: None
U (Fall, Spring)
3-0-3
Instruction in aspects of effective technical oral presentations through exposure to different workplace communication skills. As preparation for the advanced undergraduate project (UAP), students develop research topics, identify a research supervisor, and prepare a short research proposal for an oral presentation.

T. L. Eng

ADVANCED UNDERGRADUATE SUBJECTS AND GRADUATE SUBJECTS BY AREA

Systems Science and Control Engineering

6.207J Networks (New)
(Same subject as 14.15J)
Prereq: 6.041 or 14.30
U (Fall)
4-0-8 HASS
See description under subject 14.15J.

D. Acemoglu, A. Ozdaglar

6.231 Dynamic Programming and Stochastic Control
Prereq: 6.041 or 18.313; 18.100
G (Fall)
3-0-9 H-LEVEL Grad Credit

D. P. Bertsekas

6.241 Dynamic Systems and Control
Prereq: 6.003, 18.06
G (Fall)
4-0-8 H-LEVEL Grad Credit

M. A. Dahleh, A. Megretski, G. C. Verghese
6.242 Advanced Linear Control Systems
Prereq: 18.06, 6.241
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
M. A. Dahleh, A. Megretski

6.243 Dynamics of Nonlinear Systems
Prereq: 6.241; Coreq: 18.100
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
J. L. Wyatt, Jr., A. Megretski, M. Dahleh

6.245 Multivariable Control Systems
Prereq: 6.241 or 16.31
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Computer-aided design methodologies for synthesis of multivariable feedback control systems. Performance and robustness trade-offs. Model-based compensators; Q-parameterization; ill-posed optimization problems; dynamic augmentation; linear-quadratic optimization of controllers; H-infinity controller design; Mu-synthesis; model and compensator simplification; nonlinear effects. Computer-aided (MATLAB) design homework using models of physical processes. 6 Engineering Design Points.
A. Megretski

6.251 Introduction to Mathematical Programming
(Same subject as 15.081)
Prereq: 18.06
G (Fall)
4-0-8 H-LEVEL Grad Credit
Introduction to linear optimization and its extensions emphasizing both methodology and the underlying mathematical structures and geometrical ideas. Covers classical theory of linear programming as well as some recent advances in the field. Topics: simplex method; duality theory; sensitivity analysis; network flow problems; decomposition; integer programming; interior point algorithms for linear programming; and introduction to combinatorial optimization and NP-completeness.
J. N. Tsitsiklis, D. Bertsimas

6.252 Nonlinear Programming
(Same subject as 15.084)
Prereq: 18.06, 18.100
G (Spring)
3-0-9 H-LEVEL Grad Credit
A unified analytical and computational approach to nonlinear optimization problems. Unconstrained optimization methods include gradient, conjugate direction, Newton, and quasi-Newton methods. Constrained optimization methods include feasible directions, projection, interior point, and Lagrange multiplier methods. Convex analysis, Lagrangian relaxation, nondifferentiable optimization, and applications in integer programming. Comprehensive treatment of optimality conditions, Lagrange multiplier theory, and duality theory. Applications drawn from control, communications, power systems, and resource allocation problems.
R. M. Freund, D. P. Bertsekas, G. Perakis

6.253 Convex Analysis and Optimization
Prereq: 18.06, 18.100
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Core analytical issues of continuous optimization, duality, and saddle point theory, and development using a handful of unifying principles that can be easily visualized and readily understood. Discusses in detail the mathematical theory of convex sets and functions which are the basis for an intuitive, highly visual, geometrical approach to the subject. Convex optimization algorithms focus on large-scale problems, drawn from several types of applications, such as resource allocation and machine learning. Includes batch and incremental subgradient, cutting plane, proximal, and bundle methods.
D. P. Bertsekas

6.254 Game Theory with Engineering Applications
Prereq: 6.041
G (Spring)
4-0-8 H-LEVEL Grad Credit
Introduction to fundamentals of game theory and mechanism design with motivations for each topic drawn from engineering applications (including distributed control of wireline/wireless communication networks, transportation networks, pricing). Emphasis on the foundations of the theory, mathematical tools, as well as modeling and the equilibrium notion in different environments. Topics include normal form games, supermodular games, dynamic games, repeated games, games with incomplete/imperfect information, mechanism design, cooperative game theory, and network games.
R. G. Gallager, J. L. Wyatt

6.255 Optimization Methods
(Same subject as 15.093)
Prereq: 18.06
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.093.
D. Bertsimas, P. Parrilo

6.256 Algebraic Techniques and Semidefinite Optimization
Prereq: 6.251J or 6.255J
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Theory and computational techniques for optimization problems involving polynomial equations and inequalities with particular, emphasis on the connections with semidefinite optimization. Develops algebraic and numerical approaches of general applicability, with a view towards methods that simultaneously incorporate both elements, stressing convexity-based ideas, complexity results, and efficient implementations. Examples from several engineering areas, in particular systems and control applications. Topics include semidefinite programming, resultants/discriminants, hyperbolic polynomials, Groebner bases, quantifier elimination, and sum of squares.
P. Parrilo

6.262 Discrete Stochastic Processes
Prereq: 6.041, 6.431 or 18.313
G (Spring)
3-0-9 H-LEVEL Grad Credit
Review of probability and laws of large numbers; Poisson counting process and renewal processes; Markov chains (including Markov decision theory), branching processes, birth-death processes, and semi-Markov processes; continuous-time Markov chains and reversibility; random walks, martingales, and large deviations; applications from queueing, communication, control, and operations research.
R. G. Gallager, J. L. Wyatt
6.263J Data-Communication Networks
(Same subject as 16.37J)
Prereq: 6.041 or 18.313
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Modeling of the control processes in conventional and high-speed data communication networks. Develops and utilizes elementary concepts from queueing theory, algorithms, linear and nonlinear programming to study the problems of line and network protocols, distributed algorithms, quasi-static and dynamic routing, congestion control, deadlock prevention. Treats local and wide-area networks, and high-speed electronic and optical networks.
D. P. Bertsekas, E. Modiano

6.264J Queues: Theory and Applications
(Same subject as 15.072J)
Prereq: 6.262
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 15.072J.
D. Bertsimas, D. Gamarnik, J. N. Tsitsiklis

6.265J Advanced Stochastic Processes
(Same subject as 15.070J)
Prereq: 6.431, 15.085J, or 18.100
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 15.070J.
D. Gamarnik, D. Shah

6.266 Network Algorithms
Prereq: 6.436 or 6.262
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
4-0-8 H-LEVEL Grad Credit
Modern theory of networks from the algorithmic perspective with emphasis on the foundations in terms of modeling, performance analysis, and design. Topics include algorithmic questions arising in the context of scheduling, routing and congestion control in a communication network; information processing and data fusion in peer-to-peer, sensor and social networks; and efficient data storage/retrieval in a distributed storage network.
D. Shah

6.281J Logistical and Transportation Planning Methods
(Same subject as 1.203J, 15.073J, 16.76J, ESD.216J)
Prereq: 6.041
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.203J.

6.291 Seminar in Systems, Communications, and Control Research
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Advanced topics in systems, communications, control, optimization, and signal processing. Topics selected according to student and instructor interest. See instructor for specific topics to be offered in a particular term.
S. K. Mitter

Electronics, Computers, and Systems

6.301 Solid-State Circuits
Prereq: 6.012, 6.003
G (Fall)
4-2-6
Analysis and design of transistor circuits, based directly on the semiconductor physics and transistor circuit models developed in 6.012. High-frequency and low-frequency design calculations and simulation of multistage transistor circuits. Trans-linear circuits. The charge-control model. Introduction to operational-amplifier design and application. Some previous laboratory experience assumed. 4 Engineering Design Points.
J. K. Roberge, H. S. Lee

6.302 Feedback Systems
Prereq: 6.003, 2.003, or 16.04
G (Spring)
4-2-6
J. K. Roberge

6.331 Advanced Circuit Techniques
Prereq: 6.301, 6.302; permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
4-2-6 H-LEVEL Grad Credit
Following a brief classroom discussion of relevant principles, each student completes the paper design of several advanced circuits such as multiplexers, sample-and-holds, gain-controlled amplifiers, analog multipliers, digital-to-analog or analog-to-digital converters, and power amplifiers. One of each student's designs is presented to the class, and one may be built and evaluated. Associated laboratory emphasizing the use of modern analog building blocks. Enrollment limited. 12 Engineering Design Points.
J. K. Roberge

6.334 Power Electronics
Prereq: 6.012
G (Spring)
3-0-9 H-LEVEL Grad Credit
The application of electronics to energy conversion and control. Modeling, analysis, and control techniques. Design of power circuits including inverters, rectifiers, and dc-dc converters. Analysis and design of magnetic components and filters. Characteristics of power semiconductor devices. Numerous application examples, such as motion control systems, power supplies, and radio-frequency power amplifiers. 6 Engineering Design Points.
J. G. Kassakian, D. Perreault

6.336J Introduction to Numerical Simulation
(Same subject as 2.096J, 16.910J)
Prereq: 18.03 or 18.06
G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to computational techniques for the simulation of a large variety of engineering and engineered systems. Applications drawn from aerospace, mechanical, electrical, and chemical engineering, biology, and materials science. Topics: mathematical formulations; network problems; sparse direct and iterative matrix solution techniques; Newton methods for nonlinear problems; discretization methods for ordinary, time-periodic and partial differential equations; fast methods for partial differential equations and integral equations, techniques for model order reduction of dynamical systems and approaches for molecular dynamics.
L. Daniel, J. K. White
6.337J Introduction to Numerical Methods
(Same subject as 18.335J)
Prereq: 18.03 or 18.034; 18.06, 18.700, or 18.701
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 18.335J.
S. G. Johnson

6.338J Parallel Computing
(Same subject as 18.337J)
Prereq: 18.06, 18.700, or 18.701
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 18.337J.
A. Edelman

(Same subject as 2.097J, 16.920J)
Prereq: 18.03 or 18.06
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.920J.
J. Peraire, A. T. Patera, J. K. White

6.341 Discrete-Time Signal Processing
Prereq: 6.011
G (Fall)
4-0-8 H-LEVEL Grad Credit
A. V. Oppenheim, V. K. Goyal

6.342 Wavelets, Approximation, and Compression
Prereq: 18.06; 6.341 or 6.450
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Hilbert space formulation of continuous-time and discrete-time signals; sampling; orthogonal and biorthogonal signal expansions; uncertainty principles and the time-frequency plane; two-channel filter banks, iterated filter banks, discrete wavelet transforms, multiresolution analysis, wavelet bases, regularity, approximation properties, and nonlinear approximation; basics of quantization and source coding; compression, denoising, and other image processing using wavelets. Advanced topics from the current research literature.
V. K. Goyal

6.344 Digital Image Processing
Prereq: 6.003, 6.041
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
J. S. Lim

6.345J Automatic Speech Recognition
(Same subject as HST.728J)
Prereq: 6.003, 6.041
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-1-8 H-LEVEL Grad Credit
Graduate-level introduction to automatic speech recognition. Provide fundamental background in acoustic theory of speech production, properties of speech sounds, signal representation, acoustic modeling, pattern classification, search algorithms, stochastic modeling techniques (including hidden Markov modeling), and language modeling. Advanced topics include finite-state transducer formulation for speech recognition, system robustness and adaptation, audio-visual integration for speech processing, and speech understanding. Hands-on experience gained through laboratory exercises and a term project.
4 Engineering Design Points.
W. Zue, J. R. Glass

6.374 Analysis and Design of Digital Integrated Circuits
Prereq: 6.012, 6.004
G (Fall)
3-3-6 H-LEVEL Grad Credit
Device and circuit level optimization of digital building blocks. MOS device models including Deep Sub-Micron effects. Circuit design styles for logic, arithmetic, and sequential blocks. Estimation and minimization of energy consumption. Interconnect models and parasitics, device sizing and logical effort, timing issues (clock skew and jitter), and active clock distribution techniques. Memory architectures, circuits (sense amplifiers), and devices. Testing of integrated circuits. Extensive custom and standard cell layout and simulation in design projects and software labs. 4 Engineering Design Points.
R. Sarpeshkar

6.375 Complex Digital Systems Design
Prereq: 6.004
G (Spring)
5-5-2 H-LEVEL Grad Credit
Introduction to the design and implementation of large-scale digital systems using CMOS VLSI: technology and scaling; VLSI implementation styles- full custom to FPGA's; design flows and associated EDA tools; design verification; design for fabrication testing; hardware description languages (Verilog & Bluespec); power, area and delay optimizations; clocking schemes; power distribution and dissipation; I/O and packaging. Extensive use of CAD tools in weekly labs as preparation for a multi-person design project on multi-million gate FPGAs. Enrollment may be limited. 12 Engineering Design Points.
Arvind

6.376 Low Power Analog VLSI
Prereq: 6.301
G (Fall)
4-0-8 H-LEVEL Grad Credit
Comprehensive introduction to analog microelectronic design including ultra-low-power, ultra-low-noise, and feedback circuits. Device physics of the MOS transistor, including subthreshold operation and scaling to nanometer processes. VLSI chip layout and design. Transconductance amplifiers and filters, imagers, microphone circuits, current-mode circuits, analog-to-digital converters, biologically inspired circuits and systems, energy-harvesting circuits, basic electrochemistry and battery operation. Electrical modeling of non-electrical systems. System examples vary from year to year and include biomedical systems, micromechanical systems (MEMS), RF systems, sensory systems, and learning systems. The class project involves a complete design of a VLSI chip, including layout, verification, design-rule checking, and SPICE simulation. 8 Engineering Design Points.
R. Sarpeshkar
Probabilistic Systems and Communication

6.431 Applied Probability
(Subject meets with 6.041)
Prereq: Calculus II (GIR)
G (Fall, Spring)
4-0-8
Meets with undergraduate subject 6.041. Requires the completion of additional advanced home problems.
D. P. Bertsekas, J. N. Tsitsiklis

6.434J Statistics for Engineers and Scientists
(Same subject as 16.391J)
Prereq: Calculus II (GIR), 18.06, 6.431, or permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Provides a rigorous introduction to fundamentals of statistics motivated by engineering applications and emphasizing the inferred use of modern statistical software. Topics include sufficient statistics, exponential families, estimation, hypothesis testing, measures of performance, and notion of optimality.
M. Win, J. N. Tsitsiklis

6.435 System Identification
Prereq: 6.241, 6.432
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Mathematical models of systems from observations of their behavior. Time series, state-space, and input-output models. Model structures, parametrization, and identifiability. Non-parametric methods. Prediction error methods for parameter estimation, convergence, consistency, and asymptotic distribution. Relations to maximum likelihood estimation. Recursive estimation; relation to Kalman filters; structure determination; order estimation; Akaike criterion; and bounded but unknown noise models. Robustness and practical issues.
M. A. Dahleh, S. K. Mitter

6.436J Fundamentals of Probability
(Same subject as 15.085J)
Prereq: Calculus II (GIR)
G (Fall)
4-0-8 H-LEVEL Grad Credit
J. N. Tsitsiklis, D. Bertsimas

6.437 Inference and Information
Prereq: 6.041/6.431 or 6.436J
G (Spring)
4-0-8 H-LEVEL Grad Credit
Introduction to principles of Bayesian and non-Bayesian statistical inference. Hypothesis testing and parameter estimation, sufficient statistics; exponential families. EM algorithm. Log-loss inference criterion, entropy and model capacity. Kullback-Leibler distance and information geometry. Asymptotic analysis and large deviations theory. Model order estimation; nonparametric statistics. Computational issues and approximation techniques; Monte Carlo methods. Selected special topics such as universal prediction and compression.
P. Golland, A. S. Willsky, G. W. Wornell

6.438 Algorithms for Inference
Prereq: 6.041 or 6.436; 18.06
G (Fall)
4-0-8 H-LEVEL Grad Credit
Introduction to models and algorithms for efficient estimation and inference. Linear estimation via inner product spaces, Karhunen-Loeve expansions, Cholesky decompositions. Linear state-space models, Kalman filtering, RTS algorithm. Non-linear extensions and particle filtering. Autoregressive modeling and linear prediction; RLS and Levinson algorithms. Hidden Markov models; forward-backward, Viterbi, and Baum-Welsh algorithms. Introduction to graphical models and belief propagation; sum-product, min-sum, and junction tree algorithms. Selected special topics such as variational methods and mean field theory.
P. Golland, G. W. Wornell, W. T. Freeman

6.440 Essential Coding Theory
Prereq: 6.006, 6.045J
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Introduces the theory of error-correcting codes. Focuses on the essential results in the area, taught from first principles. Special focus on results of asymptotic or algorithmic significance. Principal topics include construction and existence results for error-correcting codes; limitations on the combinatorial performance of error-correcting codes; decoding algorithms; and applications to other areas of mathematics and computer science.
M. Sudan

6.441 Information Theory
Prereq: 6.041
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduction to the quantitative theory of information and its applications to reliable, efficient communication systems. Mathematical definition and properties of information and its operational meanings. Basics of large deviations and its use in information theory, coding theory, and statistics. Source coding theorem and noisy channel coding theorem; error exponents; the source-channel separation theorem; multiple access channels, broadcast channels. Readings from the literature in these topics.
M. Medard, L. Zheng

6.442 Optical Networks
Prereq: 6.041, 6.042
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduces the fundamental and practical aspects of optical network technology, architecture, design and analysis tools and techniques. The treatment of optical networks are from the architecture and system design points of view. Optical hardware technologies introduced and characterized as fundamental network building blocks on which optical transmission systems and network architectures are based. In addition to the Physical Layer, the higher network layers (Media Access Control, Network and Transport Layers) are considered together as integral parts of network design. Performance metrics, analysis and optimization techniques are developed to help guide the creation of high performance complex optical networks.
V. W. S. Chan

6.443J Quantum Information Science
(Same subject as 8.371J, 18.436J)
Prereq: 18.435
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 18.436J.
P. Shor

6.450 Principles of Digital Communication I
Prereq: 6.011
G (Fall)
3-0-9 H-LEVEL Grad Credit
Communication sources and channels; data compression; entropy and the AEP; Lempel-Ziv
universal coding; scalar and vector quantization; L2 waveforms; signal space and its representation by sampling and other expansions; aliasing; the Nyquist criterion; PAM and QAM modulation; Gaussian noise and random processes; detection and optimal receivers; fading channels and wireless communication; introduction to communication system design.

R. G. Gallager, L. Zheng

6.451 Principles of Digital Communications
Prereq: 6.450
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Coding for the AWGN channel; the gap to capacity; binary block and convolutional codes; finite fields and Reed-Solomon codes; trellis representations; codes on graphs and iterative decoding; capacity-approaching codes; lattice and trellis codes.

G. D. Forney

6.452 Principles of Wireless Communication
Prereq: 6.450
G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to design, analysis, and fundamental limits of wireless transmission systems. Wireless channel and system models; fading and diversity; resource management and power control; multiple-antenna and MIMO systems; space-time codes and decoding algorithms; multiple-access techniques and multiuser detection; broadcast codes and precoding; cellular and ad hoc network topologies; OFDM and ultra-wideband systems; architectural issues.

G. W. Wornell, L. Zheng

6.453 Quantum Optical Communication
Prereq: 6.011, 18.06
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Quantum optics: Dirac notation quantum mechanics; harmonic oscillator quantization; number states, coherent states, and squeezed states; radiation field quantization and quantum field propagation; P-representation and classical fields. Linear loss and linear amplification: commutator preservation and the Uncertainty Principle; beam splitters; phase-insensitive and phase-sensitive amplifiers. Quantum photodetector: direct detection, heterodyne detection, and homodyne detection. Second-order nonlinear optics: phasematched interactions; optical parametric amplifiers; generation of squeezed states, photon-twin beams, non-classical fourth-order interference, and polarization entanglement.

R. G. Gallager, L. Zheng

6.456 Graduate Seminar in Area I
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Student-run advanced graduate seminar with focus on topics in communications, control, signal processing, optimization. Participants give presentations outside of their own research to expose colleagues to topics not covered in the usual curriculum. Recent topics have included compressed sensing, ML principle, communication complexity, linear programming decoding, biology in EECS, distributed hypothesis testing, algorithms for random satisfaction problems, and cryptography. Open to advanced students from all areas of EECS. Enrollment limited to 12.

L. Zheng, D. Shah

6.455J Sonar, Radar, and Seismic Signal Processing
(Same subject as 2.686J, 12.518J)
Prereq: 2.004 or 6.003; 6.041; 18.075 or 18.085
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.686J.

N. C. Makris, J. C. Preisig, Woods Hole Staff

6.456J Adaptive Array Processing
Prereq: 6.438 or 6.455
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-1-8 H-LEVEL Grad Credit
Space-time random processes, beamforming, directivity, sensitivity and white noise gain metrics. Classical pattern shaping, 2-D arrays, deterministic design for sidelobe control and nulling. Adaptive array processing, design of large arrays and the "snapshot limit" problem, directional spectra estimation, sample matrix inversion (SMI) and recursive algorithms, synthetic aperture arrays, space-time adaptive systems, direction of arrival (DOA) algorithms, matched field processing and back propagation methods for range dependent environments. Applications in radar, sonar, communications and seismic array systems.

J. Preisig

Bioelectrical Engineering

6.502J Introduction to Molecular Simulations
(Same subject as HST.457J)
(Subject meets with 6.582J, HST.557J)
Prereq: Physics II (GIR); 18.03 or 18.06; 6.041 or 6.042; or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9
Introduction to the basic concepts underlying dynamical simulations of proteins and nucleic acids. Basic definitions of components that form biological systems used to develop physical models that describe the dynamics of biomolecules. Topics include classical statistical thermodynamics for calculation of macroscopic observables, normal-mode analyses of protein dynamics, and thermodynamic perturbation theory. Emphasizes actual techniques and algorithms used for such calculations. Prior knowledge of biochemistry is not required. Students taking the graduate version complete an additional project.

C. M. Stultz

6.521J Cellular Biophysics
(Same subject as 2.794J, 20.470J, HST.541J)
(Subject meets with 2.791J, 6.021J, 20.370J)
Prereq: Physics II (GIR); 18.03; 2.005, 6.002, 6.003, 6.071, 10.301, 20.110, or permission of instructor
G (Fall)
5-2-5 H-LEVEL Grad Credit
See description under subject 6.021.

D. M. Freeman, J. Han

6.522J Quantitative Physiology: Organ Transport Systems
(Same subject as 2.796J, 20.471J)
(Subject meets with 2.792J, 6.022J, 20.371J, HST.542J)
Prereq: 2.006 or 6.013; 6.021J
G (Spring)
4-2-6 H-LEVEL Grad Credit
Meets with undergraduate subject 6.022J. Requires the completion of more advanced home problems and/or an additional project.

R. G. Mark, C. M. Stultz
6.524J Molecular, Cellular, and Tissue Biomechanics
(Same subject as 2.798J, 3.971J, 10.537J, 20.410J)
Prereq: Biology (GIR); 2.002, 2.006, 6.013, 10.301, or 10.302
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.410J.
A. J. Grodzinsky, M. Bathe

6.541J Speech Communication
(Same subject as 24.968J, HST.710J)
Prereq: Permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit
Survey of human speech communication with special emphasis on the sound patterns of natural languages. Acoustic theory of speech production; physiologic and acoustic descriptions of phonetic features, prosody, speech perception, speech respiration, and speech motor control. Applications to recognition and generation of speech by machine and to speech disorders. Recommended prerequisite: mathematical background equivalent to 6.003.
L. D. Braida, R. E. Hillman, S. Shattuck-Hufnagel

6.542J Laboratory on the Physiology, Acoustics, and Perception of Speech
(Same subject as 24.966J, HST.712J)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
2-2-8 H-LEVEL Grad Credit
Experimental investigations of speech processes. Topics: measurement of articulatory movements; measurements of pressures and airflows in speech production; computer-aided waveform analysis and spectral analysis of speech; synthesis of speech; perception and discrimination of speechlike sounds; speech prosody; models for speech recognition; speech development; and other topics. Recommended prerequisites: 6.002 or 18.03. 4 Engineering Design Points.
L. D. Braida, S. Shattuck-Hufnagel

6.543J The Lexicon and Its Features
(Same subject as 9.587J, 24.941J, HST.727J)
Prereq: 24.901 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 24.941J.
D. Gow, D. Steriade, S. Shattuck-Hufnagel

6.551J Acoustics of Speech and Hearing
(Same subject as HST.714J)
Prereq: 8.03, 6.003; or permission of instructor
G (Fall)
4-1-7 H-LEVEL Grad Credit
Provides background for understanding how the acoustics and mechanics of the speech production and auditory systems define what sounds we are capable of producing and what sounds we can sense. Particular focus on the acoustic cues used in determining the direction of a sound source; the mechanisms involved in speech production; the mechanisms used by the auditory system to transduce and analyze sounds; and sound perception (absolute detection, discrimination, masking, and auditory frequency selectivity). 4 Engineering Design Points.

6.552J Signal Processing by the Auditory System: Perception
(Same subject as HST.716J)
Prereq: 6.003; 6.041 or 6.431; or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Studies information processing performance of the human auditory system in relation to current physiological knowledge. Examines mathematical models for the quantification of auditory-based behavior and the relation between behavior and peripheral physiology, reflecting the tono-topic organization and stochastic responses of the auditory system. Mathematical models of psychophysical relations, incorporating quantitative knowledge of physiological transformations by the peripheral auditory system.
L. D. Braida

6.555J Biomedical Signal and Image Processing
(Same subject as 16.456J, HST.582J)
Prereq: 6.003, 2.004, 16.004, or 18.085
G (Spring)
3-6-3 H-LEVEL Grad Credit
See description under subject HST.582J.
J. Greenberg, E. Adalsteinsson, W. Wells, G. Clifford

6.556J Data Acquisition and Image Reconstruction in MRI
(Same subject as HST.580J)
Prereq: 6.011
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Applies analysis of signals and noise in linear systems, sampling, and Fourier properties to magnetic resonance (MR) imaging acquisition and reconstruction. Provides adequate foundation for MR physics to enable study of RF excitation design, efficient Fourier sampling, parallel encoding, reconstruction of non-uniformly sampled data, and the impact of hardware imperfections on reconstruction performance. Surveys active areas of MR research. Assignments include MATLAB-based work with real data. Includes visit to a scan site for human MR studies.
E. Adalsteinsson

6.561J Fields, Forces, and Flows in Biological Systems
(Same subject as 2.795J, 10.539J, 20.430J, HST.544J)
Prereq: 6.013, 2.005, 10.302, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.430J.
A. J. Grodzinsky, D. Lauffenburger

(Same subject as 20.482J)
Prereq: 6.021J, 6.034, 6.046, 6.336J, 7.91J, 18.417, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Describes and illustrates computational approaches to solving problems in systems biology. A series of case studies demonstrates how an effective match between the statement of a biological problem and the selection of an appropriate algorithm or computational technique can lead to fundamental advances. Covers several discrete and numerical algorithms used in simulation, feature extraction and optimization for molecular, network, and systems models in biology.
B. Tidor, J. K. White
6.582J Molecular Simulations
(Same subject as HST.557J)
(Subject meets with 6.502J, HST.457J)
Prereq: Physics II (GIR); 18.03 or 18.06; 6.041 or 6.042; or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to the basic concepts underlying dynamical simulations of proteins and nucleic acids. Basic definitions of components that form biological systems used to develop physical models that describe the dynamics of biomolecules. Topics include classical statistical thermodynamics for calculation of macroscopic observables, normal-mode analyses of protein dynamics, and thermodynamic perturbation theory. Emphasizes actual techniques and algorithms used for such calculations. Prior knowledge of biochemistry is not required. Students taking the graduate version complete an additional project.

C. M. Stultz

Electrodynamics

6.602 Fundamentals of Photonics
(Subject meets with 6.621)
Prereq: 6.003; 6.007, 6.013, or 8.07
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
4-0-8
Fundamentals of optical and opto-electronic phenomena and devices: topics include electromagnetic waves in media and at interfaces, interference, Gaussian beams, resonators, waveguides, and integrated optics. Quantum electronics: topics include thermal radiation, photo detection, quantum mechanics, light-matter interaction, quantum theory of light. Lasers: topics include gas, solid-state and semiconductor lasers, laser dynamics, Q-switching and mode-locking.
F. X. Kaertner

6.608J Introduction to Particle Accelerators
(Subject as 8.277J)
Prereq: 6.013 or 8.07
U (Spring)
3-0-9
See description under subject 8.277J.
W. Barletta

6.621 Fundamentals of Photonics
(Subject meets with 6.602)
Prereq: 6.003; 6.007, 6.013, 8.07 or 6.630
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
4-0-8 H-LEVEL Grad Credit
Meets with undergraduate subject 6.602, but requires the completion of additional homework assignments. See subject description under 6.602.
F. Kaertner

6.630 Electromagnetics
(Subject meets with 6.013)
Prereq: 6.003 or 6.007
G (Fall)
3-0-9 H-LEVEL Grad Credit
Explores electromagnetic phenomena in modern applications, including wireless and optical communications, circuits, computer interconnects and peripherals, microwave communications and radar, antennas, sensors, micro-electromechanical systems, and power generation and transmission. Fundamentals include quasistatic and dynamic solutions to Maxwell’s equations, waves, radiation, and diffraction; coupling to media and structures; guided and unguided waves; modal expansions; resonance; acoustic analogs; and forces, power, and energy. Students taking graduate version complete different assignments. Meets with 6.013 in fall term only.
D. H. Staelin, E. P. Ippen, M. Zahn

6.631 Optics and Photonics
Prereq: 6.013 or 8.07
G (Fall)
3-0-9 H-LEVEL Grad Credit
J. G. Fujimoto

6.632 Electromagnetic Wave Theory
Prereq: 6.013, 6.630, or 8.07
G (Spring)
3-0-9 H-LEVEL Grad Credit
Solutions to Maxwell equations and physical interpretation. Topics include: waves in media, equivalence principle, duality and complementarity, Huygens’ principle, Fresnel and Fraunhofer diffraction, radiation and dyadic Green’s functions, scattering, metamaterials, Lorentz transformation, and Maxwell-Minkowski theory. Examples deal with limiting cases of Maxwell’s theory and diffraction and scattering of electromagnetic waves.

Staff

6.634J Nonlinear Optics
(Same subject as 8.431J)
Prereq: 6.013 or 8.07
G (Spring)
3-0-9 H-LEVEL Grad Credit
E. P. Ippen, J. G. Fujimoto

6.637 Optical Signals, Devices, and Systems
(Subject meets with 6.161)
Prereq: 6.003
G (Fall)
3-0-9 H-LEVEL Grad Credit
Principles of operation and applications of devices and systems for optical signal generation, transmission, detection, storage, processing and display. Topics include review of the basic properties of electromagnetic waves; coherence and interference; diffraction and holography; Fourier optics; coherent and incoherent imaging and signal processing systems; optical properties of materials; lasers and LEDs; electro-optic and acousto-optic light modulators; photorefractive and liquid-crystal light modulation; spatial light modulators and displays; optical waveguides and fiber-optic communication systems; photodetectors; 2-D and 3-D optical storage technologies; adaptive optical systems; role of optics in next-generation computers. Student research paper on a specific contemporary topic required. Recommended prerequisites: 6.007 or 8.03.
C. Warde

6.638 Ultrafast Optics
Prereq: 6.602, 6.621, 6.630, or 6.631
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Detailed exposition of the principles involved in ultrashort pulse generation, propagation, and characterization. Linear and nonlinear pulse shaping processes are discussed. Optic solitons, pulse compression. Laser prin-

F. X. Kaertner

6.641 Electromagnetic Fields, Forces, and Motion
Prereq: 6.013
G (Spring)
4-0-8 H-LEVEL Grad Credit

Electric and magnetic quasistatic forms of Maxwell’s equations applied to dielectric, conduction, and magnetization boundary value problems. Electromagnetic forces, force densities, and stress tensors, including magnetization and polarization. Thermodynamics of electromagnetic fields, equations of motion, and energy conservation. Applications to synchronous, induction, and commutator machines; sensors and transducers; microelectromechanical systems; propagation and stability of electromechanical waves; and charge transport phenomena.

M. Zahn, J. H. Lang

6.642 Continuum Electromechanics
Prereq: 6.641 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
4-0-8 H-LEVEL Grad Credit


M. Zahn

6.651J Introduction to Plasma Physics I
(Same subject as 8.613J, 22.611J)
Prereq: 6.013, 8.07, or 22.105; 18.04 or Coreq: 18.075
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.611J.

J. Egedal-Pedersen

6.652J Introduction to Plasma Physics II
(Same subject as 8.614J, 22.612J)
Prereq: 6.651J, 8.613J, or 22.611J
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 8.614J.

6.673 Introduction to Numerical Simulation in Electrical Engineering
Prereq: 6.012 or 6.013
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Selection of a simulation model and physical approximations. Solution of nonlinear coupled PDEs in 1-D through finite difference and finite element methods, Newton’s method, and variants. Finite difference and finite element methods in 2-D and sparse matrix methods emphasizing conjugate gradient algorithms. Semiconductor devices used as primary examples; additional examples drawn from E&M modeling, nonlinear pulse propagation, and laser physics.

P. L. Hagelstein

6.685 Electric Machines
Prereq: 6.061 or 6.690; or permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit


J. L. Kirtley, Jr.

6.690 Introduction to Electric Power Systems
(Subject meets with 6.061)
Prereq: 6.002, 6.013
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Meets with undergraduate subject 6.061. Requires the completion of additional advanced home problems. See description under subject 6.061.

J. L. Kirtley, Jr.

6.691 Seminar in Electric Power Systems
Prereq: 6.061 or 6.690; or permission of Instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Planning and operation of modern electric power systems. Content varies with current interests of instructor and class; emphasis on engineering aspects, but economic issues may be examined. Core topics include overview of power system structure and operation; representation of components, including transmission lines, transformers, generating plants, loads; power flow analysis, dynamics and control of multimachine systems, steady-state and transient stability, system protection; economic dispatch; mobil and isolated power systems; computation and simulation.

J. L. Kirtley, Jr.

Solid-State Materials and Devices

6.701 Introduction to Nanoelectronics
(Subject meets with 6.719)
Prereq: 6.003
U (Spring)
4-0-8

Transistors at the nanoscale. Quantization, wavefunctions, and Schrödinger’s equation. Introduction to electronic properties of molecules, carbon nanotubes, and crystals. Energy band formation and the origin of metals, insulators and semiconductors. Ballistic transport, Ohm’s law, ballistic versus traditional MOSFETs, fundamental limits to computation.

M. A. Baldo

6.719 Nanoelectronics
(Subject meets with 6.701)
Prereq: 6.003
G (Spring)
4-0-8 H-LEVEL Grad Credit

Meets with undergraduate subject 6.701, but requires the completion of additional/different
homework assignments and or projects. See subject description under 6.701.

M. A. Baldo

6.720J Integrated Microelectronic Devices
(Same subject as 3.43J)
Prereq: 6.012 or 3.42
G (Fall)
4-0-8 H-LEVEL Grad Credit

The physics of microelectronic semiconductor devices for silicon integrated circuit applications. Topics: semiconductor fundamentals, p-n junction, metal-oxide semiconductor structure, metal-semiconductor junction, MOS field-effect transistor, and bipolar junction transistor. Emphasis on physical understanding of device operation through energy band diagrams and short-channel MOSFET device design. Issues in modern device scaling outlined. Includes device characterization projects and device design project. 2 Engineering Design Points.

J. A. del Álamo, H. L. Tuller

6.728 Applied Quantum and Statistical Physics
Prereq: 6.003, 18.06
G (Fall)
4-0-8 H-LEVEL Grad Credit

Elementary quantum mechanics and statistical physics. Introduces applied quantum physics. Emphasizes experimental basis for quantum mechanics. Applies Schrodinger’s equation to the free particle, tunneling, the harmonic oscillator, and hydrogen atom. Variational methods. Elementary statistical physics; Fermi-Dirac, Bose-Einstein, and Boltzmann distribution functions. Simple models for metals, semiconductors, and devices such as electron microscopes, scanning tunneling microscope, thermionic emitters, atomic force microscope, and more.

P. L. Hagelstein, T. P. Orlando, K. K. Berggren

6.729 Molecular Electronics
Prereq: 6.728
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Electronic and optical properties of molecular materials. Intermolecular charge transport discussion includes localization, polarons, Marcus theory, disordered materials, and percolation models. Optical properties discussed include radiationless transitions and energy transfer, and the ramifications of molecular conformation changes. Relevant devices include organic light emitting devices, organic photovoltaic cells and organic transistors. Subject concludes with discussion of molecular circuits in biology. This is an advanced topics subject. A text, supplementary material, and references are provided.

M. Baldo

6.730 Physics for Solid-State Applications
Prereq: 6.013, 6.728
G (Spring)
5-0-7 H-LEVEL Grad Credit

Classical and quantum models of electrons and lattice vibrations in solids, emphasizing physical models for elastic properties, electronic transport, and heat capacity. Crystal lattices, electronic energy band structures, phonon dispersion relations, effective mass theorem, semi-classical equations of motion, electron scattering and semiconductor optical properties. Band structure and transport properties of selected semiconductors. Connection of quantum theory of solids with quasi-Fermi levels and Boltzmann transport used in device modeling.

T. P. Orlando, R. Ram

6.731 Semiconductor Optoelectronics: Theory and Design
Prereq: 6.728, 6.012
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Focuses on the physics of the interaction of photons with semiconductor materials. The band theory of solids is used to calculate the absorption and gain of semiconductor media. The rate equation formalism is used to develop the concepts of laser threshold, population inversion and modulation response. Matrix methods and coupled mode theory are applied to resonator structures such as distributed feedback lasers, tunable lasers and microring devices. The course is also intended to introduce students to noise models for semiconductor devices and to applications of optoelectronic devices to fiber optic communications.

R. J. Ram

6.732 Physics of Solids
Prereq: 6.730 or 8.231
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
4-0-8 H-LEVEL Grad Credit

Continuation of 6.730 emphasizing applications-related physical issues in solids. Topics: electronic structure and energy band diagrams of semiconductors, metals, and insulators; Fermi surfaces; dynamics of electrons; classical diffusive transport phenomena such as electrical and thermal conduction and thermoelectric phenomena; quantum transport in tunneling and ballistic devices; optical properties of metals, semiconductors, and insulators; photon-lattice interactions; optical devices based on interband and intersubband transitions; magnetic properties of solids; exchange energy and magnetic ordering; magneto-oscillatory phenomena; quantum Hall effect; superconducting phenomena and simple models.

Q. Hu

6.763 Applied Superconductivity
Prereq: 6.728
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit


T. P. Orlando

6.772 Compound Semiconductor and Heterostructure Devices
Prereq: 6.012
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
4-0-8 H-LEVEL Grad Credit

Physics, modeling, and application of compound semiconductors (primarily III-Vs and Si-Ge) in high speed electronic, optoelectronic, and photonic devices and ICs. The materials palette; energy band and effective mass concepts; theory and practice of III-V and Si-Ge heterojunctions, quantum structures, and strained layers; metal-semiconductor diodes and field effect transistors (MESFETs); heterojunction field effect transistors (HFETs) and bipolar transistors (HBTs); dielectric waveguides and photonic lattices; LEDs, laser diodes, photodetectors, and other optoelectronic devices; heterogeneous integration with Si.

C. G. Fonstad, Jr., T. A. Palacios

6.774 Physics of Microfabrication: Front End Processing
Prereq: 6.152J
G (Fall)
3-0-9 H-LEVEL Grad Credit

Advanced physical models and practical aspects of front-end microfabrication processes, particularly oxidation, diffusion, ion implantation, and epitaxy. Topics relevant to high performance MOS and bipolar devices, including ultra-thin gate oxides, gate etching, implant damage enhanced diffusion, advanced metrology, stress effects on oxidation, process induced strain
techniques, and strained Si/SiGe materials. CMOS process integration concepts, and impacts of processing on device characteristics. Students use modern process simulation tools.

J. L. Hoyt, L. R. Reif

6.775 CMOS Analog and Mixed-Signal Circuit Design
Prereq: 6.301
G (Spring)
3-0-9 H-LEVEL Grad Credit

A detailed exposition of the principles involved in designing and optimizing analog and mixed-signal circuits in CMOS technologies. Small-signal and large-signal models. Systematic methodology for device sizing and biasing. Basic circuit building blocks. Operational amplifier design. Large signal considerations. Principles of switched capacitor networks including switched-capacitor and continuous-time integrated filters. Basic and advanced A/D and D/A converters, delta-sigma modulators, RF and other signal processing circuits. Design projects on op amps and subsystems are a required part of the subject. 4 Engineering Design Points.

H. S. Lee, C. G. Sodini

6.776 High Speed Communication Circuits
Prereq: 6.301
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-3-6 H-LEVEL Grad Credit

Principles and techniques for integrated circuit design within communication systems such as wireless and broadband data links. Circuit blocks for communication transceivers and phase-locked loops, which include broadband, narrowband, and low-noise amplifiers, mixers, voltage-controlled oscillators, power amplifiers, and high speed frequency dividers. Passive component design of on-chip inductors and capacitors. Analysis of distributed effects using transmission line modeling, S-parameters, Smith chart. Significant laboratory component.

J. L. Dawson, H. S. Lee

6.777J Design and Fabrication of MEMS
(Same subject as 2.372J)
Prereq: 6.003 or 2.004, Physics II (GIR); or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Introduction to microsystem design. Material properties, microfabrication technologies, structural behavior, sensing methods, fluid flow, macroscale transport, noise, and amplifiers feedback systems. Student teams design microsystems (sensors, actuators, and sensing/control systems) of a variety of types, (e.g., optical MEMS, bioMEMS, inertial sensors) to meet a set of performance specifications (e.g., sensitivity, signal-to-noise) using a realistic microfabrication process. Emphasis on modeling and simulation in the design process. Prior fabrication experience is desirable. 4 Engineering Design Points.

C. Livermore, J. Voldman

6.778J Materials and Processes for Microelectromechanical Devices and Systems
(Same subject as 2.373J, 3.48J, 10.584J, 16.288J)
Prereq: 6.152J/3.155J; permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 3.48J.

L. Anand, K. F. Jensen, M. A. Schmidt, C. V. Thompson, B. L. Wardle

6.780J Control of Manufacturing Processes
(Same subject as 2.830J, ESD.63J)
Prereq: 2.008, 2.810, 6.041, 6.152J, or 15.064J
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 2.830J.

D. E. Hardt, D. S. Boning

6.781J Nanostructure Fabrication
(Same subject as 2.391J)
Prereq: 6.152, 6.161, or 2.710; or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit

Describes current techniques used in analyzing and fabricating nanometer-length-scale structures and devices. Covers fundamentals of optical, electron (scanning, transmission, and tunneling), and atomic-force microscopy; optical, electron, ion, and nanoimprint lithography, templated self-assembly, and resist technology. Surveys substrate characterization and preparation, facilities, and metrology requirements for nanolithography. Nanodevice processing methods such as liquid and plasma etching, lift-off, electroplating, and ion-implant are also presented. Some applications in nanoelectronics, nanomaterials, and nanophotonics are discussed.

H. I. Smith, G. Barbastathis, K. K. Berggren

6.789 Organic Optoelectronics
Prereq: Permission of Instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
4-1-7 H-LEVEL Grad Credit

Examines optical and electronic processes in organic molecules and polymers that govern the behavior of practical organic optoelectronic devices. Electronic structure of a single organic molecule is used as a guide to the electronic behavior of organic aggregate structures. Emphasis on use of organic thin films in active organic devices including organic LEDs, solar cells, photodetectors, transistors, chemical sensors, memory cells, electrochomeric devices, as well as xerography and organic nonlinear optics. Reaching the ultimate miniaturization limit of molecular electronics and related nanoscale patterning techniques of organic materials are discussed. Laboratory sessions are conducted in a research laboratory environment with the goal of exposing students to material deposition and device testing techniques.

V. Bulovic

Computer Science

6.801 Machine Vision
Prereq: 6.003 or permission of instructor
U (Fall)
3-0-9


B. K. P. Horn

6.803The Human Intelligence Enterprise
(Subject meets with 6.833)
Prereq: 6.034 or permission of instructor
U (Spring)
3-0-9

Analyzes seminal work directed at the development of a computational understanding of human intelligence, such as work on object tracking, object recognition, change representation, language evolution, and the role of symbols in learning and communication. Reviews visionary ideas of Turing, Minsky, and other influential thinkers. Examines the role of brain scanning, systems neuroscience, and cognitive psychology. Emphasis on discussion and analysis of original papers. Meets with 6.833 but assignments differ. Enrollment limited.

P. H. Winston
6.804] Computational Cognitive Science
(Same subject as 9.66j)
(Subject meets with 9.660)
Prereq: 9.07, 18.05, 6.041, or permission of instructor
U (Fall)
3-0-9
See description under subject 9.66j.
J. B. Tenenbaum

6.805 Ethics and the Law on the Electronic Frontier
(Subject meets with STS.085, STS.487)
Prereq: Permission of instructor
U (Spring)
3-0-9
Studies the growth of computer and communications technology and the new legal and ethical challenges that reflect tensions between individual rights and societal needs. Topics: computer crime; intellectual property restrictions on software; encryption, privacy, and national security; academic freedom and free speech. Students meet and question technologists, activists, law enforcement agents, journalists, and legal experts. Extensive use of the web for readings and other materials. Students engage in extensive written and oral communication exercises. STS.085 meets with 6.805 and carries HASS credit. 6.805 may be used as an Engineering Concentration Elective. Enrollment limited.
H. Abelson, M. Fischer, D. Weitzner

6.814 Database Systems (New)
(Subject meets with 6.830)
Prereq: 6.033; 6.046 or 6.006; or permission of instructor
U (Fall)
3-0-9
Topics related to the engineering and design of database systems, including data models; database and schema design; schema normalization and integrity constraints; query processing; query optimization and cost estimation; transactions; recovery; concurrency control; isolation and consistency; distributed, parallel and heterogeneous databases; adaptive databases; trigger systems; pub-sub systems; semi structured data and XML querying. Lecture and readings from original research papers. Semester-long project and paper. Students taking graduate version complete different assignments. Enrollment may be limited. 4 Engineering Design Points.
S. R. Madden

6.815 Digital and Computational Photography
(Subject meets with 6.865)
Prereq: 18.06, 6.003
U (Spring)
3-0-9
Computational photography is a new field at the convergence of photography, computer vision, image processing, and computer graphics. Fundamentals and applications of hardware and software techniques, with an emphasis on software methods. Provides sufficient background to implement new solutions to photography challenges and opportunities. Topics include cameras and image formation, image processing and image representations, high-dynamic-range imaging, human visual perception and color, single view 3-D model reconstruction, morphing, data-rich photography, Super-resolution, image-based rendering. 6 Engineering Design Points.
F. P. Durand, W. T. Freeman

6.821 Programming Languages
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Principles of functional, imperative, and logic programming languages. Meta-circular interpreters, semantics (operational and denotational), type systems (polymorphism, inference, and abstract types), object-oriented programming, modules, and multiprocessing. Case studies of contemporary programming languages. Programming experience and background in language implementation required.
D. K. Gifford

6.823 Computer System Architecture
Prereq: 6.004
G (Fall)
4-0-8 H-LEVEL Grad Credit
Emphasizes the relationship among technology, hardware organization, and programming systems in the evolution of computer architecture. Pipelined, out-of-order, and speculative execution. Superscalar, VLIW, vector, and multithreaded processors. Virtual memory and exception handling. I/O and memory systems. Parallel computers; message passing and shared memory systems. Memory models, synchronization, and cache coherence protocols. Embedded computers. Assumes an undergraduate knowledge of computer systems. 4 Engineering Design Points.
Arvind

6.824 Distributed Computer Systems Engineering
Prereq: 6.033, permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
R. T. Morris, M. F. Kaashoek

6.825 Techniques in Artificial Intelligence
Prereq: 6.041, 6.042 (6.046) and 6.034 desirable
G (Spring)
3-0-9 H-LEVEL Grad Credit
A graduate-level introduction to artificial intelligence. Topics include representation and inference in first-order logic; modern deterministic and decision-theoretic planning techniques; basic supervised learning methods; and Bayesian network inference and learning.
L. Kaelbling

6.826 Principles of Computer Systems
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
An introduction to the basic principles of computer systems with emphasis on the use of rigorous techniques as an aid to understanding and building modern computing systems.
Particular attention paid to concurrent and distributed systems. Topics include: specification and verification, concurrent algorithms, synchronization, naming, Networking, replication techniques (including distributed cache management), and principles and algorithms for achieving reliability.

_B. W. Lampson_

**6.827 Multithreaded Parallelism: Languages and Compilers**

Prereq: 6.001, 6.042J

Acad Year 2009–2010: G (Fall)

Acad Year 2010–2011: Not offered

3-0-9 H-LEVEL Grad Credit


_Arvind_

**6.828 Operating System Engineering**

Prereq: 6.033, 6.170

G (Fall)

3-6-3 H-LEVEL Grad Credit

Fundamental design and implementation issues in the engineering of operating systems. Lectures based on the study of a symmetric multiprocessor version of UNIX version 6 and research papers. Topics include virtual memory; file system; threads; context switches; kernels; interrupts; system calls; interprocess communication; coordination, and interaction between software and hardware. Individual laboratory assignments accumulate in the construction of a minimal operating system (for an x86-based personal computer) that implements the basic operating system abstractions and a shell. Knowledge of programming in the C language is a prerequisite. 6 Engineering Design Points.

_M. F. Kaashoek_

**6.829 Computer Networks**

Prereq: 6.033 or permission of instructor

G (Spring)

4-0-8 H-LEVEL Grad Credit

Topics on the engineering and analysis of network protocols and architecture, including architectural principles for designing heterogeneous networks; transport protocols; internet routing foundations and practice; router design; congestion control and network resource management; wireless networks; network security; naming; overlay and peer-to-peer networks. Readings from original research papers and Internet RFCs. Semester-long project and paper. Enrollment may be limited. 4 Engineering Design Points.

_H. Balakrishnan_

**6.830 Database Systems**

(Subject meets with 6.814)

Prereq: 6.033; 6.046J or 6.006; or permission of instructor

G (Fall)

3-0-9 H-LEVEL Grad Credit

Topics related to the engineering and design of database systems, including data models; database and schema design; schema normalization and integrity constraints; query processing; query optimization and cost estimation; transactions; recovery; concurrency control; isolation and consistency; distributed, parallel and heterogeneous databases; adaptive databases; trigger systems; pub-sub systems; semi structured data and XML querying. Lecture and readings from original research papers. Semester-long project and paper. Students taking graduate version complete different assignments. Enrollment may be limited. 4 Engineering Design Points.

_S. R. Madden_

**6.831 User Interface Design and Implementation**

(Subject meets with 6.813)

Prereq: 6.005, 6.170, or permission of instructor

G (Spring)

3-0-9 H-LEVEL Grad Credit

Design, implementation, and evaluation of human-computer interfaces. Human capabilities, including the human information processing model, perception, Fitts’ Law, memory, attention, and color vision; task analysis, user-centered design, design principles; low-fidelity prototyping; heuristic evaluation, formative evaluation, controlled experiments; model-view-controller, input models, output models, constraints, layout, animation, and automatic user interface generation. Readings from current literature, assignments related to research topics and experiment design and analysis, and substantial, semester-long group programming project. Students taking the graduate version complete different assignments. 6 Engineering Design Points.

_R. C. Miller_

**6.832 Underactuated Robotics**

Prereq: 6.141, 2.12, 2.165, or permission of instructor

G (Spring)

3-0-9 H-LEVEL Grad Credit

Nonlinear dynamics and control of underactuated mechanical systems, with an emphasis on machine learning methods. Topics include nonlinear dynamics of passive robots (walkers, swimmers, flyers), motion planning, partial feedback linearization, energy-shaping control, analytical optimal control, reinforcement learning/approximate optimal control, and the influence of mechanical design on control. Discussions include examples from biology and applications to legged locomotion, compliant manipulation, underwater robots, and flying machines.

_R. Tedrake_

**6.833 The Human Intelligence Enterprise**

(Subject meets with 6.803)

Prereq: 6.034

G (Spring)

3-0-9 H-LEVEL Grad Credit

Meets with undergraduate subject 6.803. Intended, in part, to prepare students for MEng thesis work in the Artificial Intelligence concentration. Requires completion of supplementary exercises and a substantial term project. Enrollment limited.

_P. H. Winston_

**6.834 Cognitive Robotics**

(Same subject as 16.412J)

Prereq: 6.041 or 6.042J and 16.410, 16.413, 6.034, or 6.825

Acad Year 2009–2010: Not offered

Acad Year 2010–2011: G (Spring)

3-0-9 H-LEVEL Grad Credit

See description under subject 16.412J.

_B. C. Williams_

**6.835 Intelligent Multimodal User Interfaces**

Prereq: 6.034; 6.005 or 6.170; or permission of instructor

Acad Year 2009–2010: Not offered

Acad Year 2010–2011: G (Spring)

3-0-9 H-LEVEL Grad Credit

Implementation and evaluation of intelligent multi-modal user interfaces, taught from a combination of hands-on exercises and papers from the original literature. Topics include basic technologies for handling speech, vision, pen-based interaction, and other modalities, as well as various techniques for combining modalities. Substantial readings and a term project, where students build an interface to illustrate one
or more themes of the course. 8 Engineering Design Points.
R. Davis

6.837 Computer Graphics
Prereq: Calculus II (GIR), 6.005; or permission of instructor
U (Fall)
3-0-9
Introduction to computer graphics algorithms, software and hardware. Topics include ray tracing, the graphics pipeline, transformations, texture mapping, shadows, sampling, global illumination, splines, animation and color. 6 Engineering Design Points.
F. P. Durand

6.838 Advanced Topics in Computer Graphics
Prereq: 6.837
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
In-depth study of an active research topic in computer graphics. Topics change each term. Readings from the literature, student presentations, short assignments, and a programming project.
F. P. Durand

6.839 Advanced Computer Graphics
Prereq: 18.06, 6.005, 6.837, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
A graduate level course investigates computational problems in rendering, animation, and geometric modeling. The course draws on advanced techniques from computational geometry, applied mathematics, statistics, scientific computing and other. Substantial programming experience required.
F. P. Durand

6.840 Theory of Computation
(Same subject as 18.404J)
Prereq: 18.310 or 18.062J
G (Fall)
4-0-8 H-LEVEL Grad Credit (except for Course 18 students)
See description under subject 18.404J.
M. Sipser

6.841 Advanced Complexity Theory
(Same subject as 18.405J)
Prereq: 6.840J/18.404J
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 18.405J.
Information: M. Sudan, M. Sipser

6.842 Randomness and Computation
Prereq: 6.046J, 6.840J
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
The power and sources of randomness in computation. Connections and applications to computational complexity, computational learning theory, cryptography and combinatorics. Topics include: probabilistic proofs, uniform generation and approximate counting, Fourier analysis of Boolean functions, computational learning theory, expander graphs, pseudorandom generators, derandomization.
R. Rubinfeld

6.846 Parallel Computing
Prereq: 6.004 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduction to parallel and multicore computer architecture and programming. Topics include the design and implementation of multicore processors; networking, video, continuum, particle and graph applications for multicores; communication and synchronization algorithms and mechanisms; locality in parallel computations; computational models, including shared memory, streams, message passing, and data parallel; multicore mechanisms for synchronization, cache coherence, and multithreading. Performance evaluation of multicore processors; compilation and runtime systems for parallel computing. Substantial project required. 4 Engineering Design Points.
A. Agarwal

6.850 Geometric Computing
Prereq: 6.046J
G (Spring)
3-0-9 H-LEVEL Grad Credit
R. Indyk

6.851 Advanced Data Structures
Prereq: 6.046J
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
More advanced and powerful data structures for answering several queries on the same data. Such structures are crucial in particular for designing efficient algorithms. Dictionaries; hashing; search trees. Self-adjusting data structures; linear search; splay trees; dynamic optimality. Integer data structures; word RAM. Predecessor problem; van Emde Boas priority queues; y-fast trees; fusion trees. Lower bounds; cell-probe model; round elimination. Dynamic graphs; link-cut trees; dynamic connectivity. Strings; text indexing; suffix arrays; suffix trees. Static data structures; compact arrays; rank and select. Succinct data structures; tree encodings; implicit data structures. External-memory and cache-oblivious data structures; B-trees; buffer trees; tree layout; ordered-file maintenance. Temporal data structures; persistence; retroactivity.
E. D. Demaine

6.852 Distributed Algorithms
(Same subject as 18.437J)
Prereq: 6.046J
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Design and analysis of concurrent algorithms, emphasizing those suitable for use in distributed networks. Process synchronization, allocation of computational resources, distributed consensus, distributed graph algorithms, election of a leader in a network, distributed termination, deadlock detection, concurrency control, communication, and clock synchronization. Special consideration given to issues of efficiency and fault tolerance. Formal models and proof methods for distributed computation.
N. A. Lynch

6.854 Advanced Algorithms
(Same subject as 18.415J)
Prereq: 6.041J, 6.042J, or 18.440J; 6.046J
G (Fall)
5-0-7 H-LEVEL Grad Credit
First-year graduate subject in algorithms. Emphasizes fundamental algorithms and advanced methods of algorithmic design, analysis, and
implementation. Surveys a variety of computational models and the algorithms for them. Data structures, network flows, linear programming, computational geometry, approximation algorithms, online algorithms, parallel algorithms, external memory, streaming algorithms.

D. R. Karger

6.855| Network Optimization
(Same subject as 15.082J, ESD.78J)
Prereq: 6.046J, 6.251J, 15.081J, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 15.082J.
A. S. Schulz

6.856| Randomized Algorithms
(Same subject as 18.416J)
Prereq: 6.854J, 6.041 or 6.042J
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
5-0-7 H-LEVEL Grad Credit
Studies how randomization can be used to make algorithms simpler and more efficient via random sampling, random selection of witnesses, symmetry breaking, and Markov chains. Models of randomized computation. Data structures: hash tables, and skip lists. Graph algorithms: minimum spanning trees, shortest paths, and minimum cuts. Geometric algorithms: convex hulls, linear programming in fixed or arbitrary dimension. Approximate counting; parallel algorithms; online algorithms; derandomization techniques; and tools for probabilistic analysis of algorithms.
D. R. Karger

6.857| Network and Computer Security
Prereq: 6.033, 6.042J
G (Spring)
3-0-9 H-LEVEL Grad Credit
Techniques for achieving security in multi-user computer systems and distributed computer systems. Topics: physical security; discretionary and mandatory access control; biometrics; information-flow models of security; covert channels; elementary cryptography; public-key cryptography; logic of authentication; electronic cash; viruses; firewalls; electronic voting; risk assessment; secure web browsers.
R. L. Rivest

6.859| Integer Programming and Combinatorial Optimization
(Same subject as 15.083J)
Prereq: 15.081J or permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 15.083J.
D. J. Bertsimas, A. S. Schulz

6.863| Natural Language and the Computer Representation of Knowledge
(Same subject as 9.611J)
Prereq: 6.034
G (Spring)
3-3-6 H-LEVEL Grad Credit
Relationship between computer representation of knowledge and the structure of natural language. Emphasizes development of the analytical skills necessary to judge the computational implications of grammatical formalisms, and uses concrete examples to illustrate particular computational issues. Efficient parsing algorithms for context-free grammars; augmented transition network grammars. Question answering systems. Extensive laboratory work on building natural language processing systems. 8 Engineering Design Points.
R. C. Berwick

6.864| Advanced Natural Language Processing
Prereq: 6.046J or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Graduate introduction to natural language processing, the study of human language from a computational perspective. Syntactic, semantic and discourse processing models. Emphasis on machine learning or corpus-based methods and algorithms. Use of these methods and models in applications including syntactic parsing, information extraction, statistical machine translation, dialogue systems, and summarization.
R. A. Barzilay, M. J. Collins

6.865| Advanced Computational Photography
(Subject meets with 6.815)
Prereq: 6.003, 18.06
G (Spring)
3-0-9 H-LEVEL Grad Credit
Requires the completion of additional advanced homework assignments and presentation of a research paper. See subject description under 6.815.
F. P. Durand, W. T. Freeman

6.866| Machine Vision
Prereq: 6.003 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Intensive introduction to the process of generating a symbolic description of the environment from an image. Students expected to attend the 6.801 lectures as well as occasional seminar meetings on special topics. Material presented in 6.801 is supplemented by reading from the literature. Students required to prepare a paper analyzing research in a selected area.
B. K. P. Horn

6.867| Machine Learning
Prereq: 6.034, 18.06, 6.041 or 18.05
G (Fall)
3-0-9 H-LEVEL Grad Credit
Principles, techniques, and algorithms in machine learning from the point of view of statistical inference, representation, generalization, and model selection; and methods such as linear/additive models, active learning, boosting, support vector machines, hidden Markov models, and Bayesian networks.
T. Jaakkola, L. P. Kaelbling, M. J. Collins

6.868| The Society of Mind
(Same subject as MAS.731J)
Prereq: Must have read The Society of Mind and The Emotion Machine; permission of instructor
G (Spring)
2-0-10 H-LEVEL Grad Credit
Introduction to a theory that tries to explain how minds are made from collections of simpler processes. Treats such aspects of thinking as vision, language, learning, reasoning, memory, consciousness, ideals, emotions, and personality. Incorporates ideas from psychology, artificial intelligence, and computer science to resolve theoretical issues such as wholes vs. parts, structural vs. functional descriptions, declarative vs. procedural representations, symbolic vs. connectionist models, and logical vs. common-sense theories of learning. Enrollment limited.
M. Minsky

6.869| Advances in Computer Vision
Prereq: 6.041 or 6.042; 18.06
G (Spring)
3-0-9 H-LEVEL Grad Credit
Advanced topics in computer vision with a focus on the use of machine learning techniques and applications in graphics and human-computer interface. Topics include image representations, texture models, structure-from-motion algorithms, Bayesian techniques, object and scene recognition, tracking, shape modeling, and
image databases. Applications may include face recognition, multimodal interaction, interactive systems, cinematic special effects, and photorealistic rendering. Covers topics complementary to 6.801/6.866; these subjects may be taken in sequence.

W. T. Freeman, A. Torralba

6.870 Advanced Topics in Computer Vision
Prereq: 6.801/6.866 or 6.869 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Seminar exploring advanced research topics in the field of computer vision; focus varies with lecturer. Typically structured around discussion of assigned research papers and presentations by students. Example research areas explored in this seminar include learning in vision, computational imaging techniques, multimodal human-computer interaction, biomedical imaging, representation and estimation methods used in modern computer vision.

W. T. Freeman, P. Golland, B. K. P. Horn, A. Torralba

6.872J Biomedical Computing
(Same subject as HST.950J)
Prereq: 6.034
G (Fall)
3-0-9 H-LEVEL Grad Credit

Analyzes computational needs of clinical medicine, reviews systems and approaches that have been used to support those needs, and the relationship between clinical and gene and protein measurements. Topics: the nature of clinical data; architecture and design of health-care information systems; privacy and security issues; medical expert systems; introduction to bioinformatics. Case studies and guest lectures describe contemporary systems and research projects. Term project using large clinical and genomic data sets integrates classroom topics.

6 Engineering Design Points.

P. Szolovits, I. Kohane, L. Ohno-Machado

6.873J Biomedical Decision Support
(Same subject as HST.951J)
Prereq: 6.034 or HST.947; programming skills or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Presents the main concepts of decision analysis, artificial intelligence, and predictive model construction and evaluation in the specific context of medical applications. Emphasizes the advantages and disadvantages of using these methods in real-world systems. Technical focus on decision analysis, knowledge-based systems (qualitative and quantitative), learning systems (including logistic regression, classification trees, neural networks), and techniques to evaluate the performance of such systems. Students produce a final project using the methods learned in the subject, based on actual clinical data. Required for students in the master's program in medical informatics, but open to other graduate students and advanced undergraduates.

R. Lacson, S. Vinterbo

6.874 Computational Systems Biology
Prereq: Biology (GIR), 18.440 or 6.041
G (Spring)
3-0-9 H-LEVEL Grad Credit

Computational approaches and algorithms for contemporary problems in systems biology, with a focus on models of biological systems, including regulatory network discovery and validation. Topics include (1) genotypes, regulatory factor binding and motif discovery, whole genome RNA expression; (2) Regulatory networks: discovery, validation, data integration, protein-protein interactions, signaling, whole genome chromatin immunoprecipitation analysis; (3) Experimental design: model validation, interpretation of interventions. Computational methods discussed include directed and undirected graphical models such as Bayesian networks, factor graphs, Dirichlet processes, and topic models. Multidisciplinary team oriented final research project.

D. K. Gifford, T. S. Jaakkola

6.875J Cryptography and Cryptanalysis
(Same subject as 18.425J)
Prereq: 6.046J
G (Spring)
3-0-9 H-LEVEL Grad Credit

A rigorous introduction to modern cryptography. Emphasis on the fundamental cryptographic primitives of public-key encryption, digital signatures, pseudo-random number generation, and basic protocols and their computational complexity requirements.

S. Goldwasser, S. Micali

6.876J Advanced Topics in Cryptography
(Same subject as 18.426J)
Prereq: 6.875J/18.425J
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Recent results in cryptography, interactive proofs, and cryptographic game theory. Lectures by instructor, invited speakers, and students.

S. Goldwasser, S. Micali

6.877J Computational Evolutionary Biology
(Same subject as HST.949J)
(Subject meets with 6.048)
Prereq: 6.046J, 6.047, 7.36, 6.807, or HST.508; or permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-3-6 H-LEVEL Grad Credit

See description under subject 6.877J.

R. C. Berwick

6.878J Advanced Computational Biology: Genomes, Networks, Evolution
(Same subject as HST.507J)
(Subject meets with 6.047)
Prereq: 6.006, 6.041, and Biology (GIR); or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

See description for 6.047. Additionally examines recent publications in the areas covered, with research-style assignments. A more substantial final project is expected, which can lead to a thesis and publication.

M. Kelis

6.881–6.899 Special Subjects in Computer Science

Can be repeated for credit

Opportunity for group study of advanced subjects related to computer science not otherwise included in curriculum. Offerings initiated by members of the EECS faculty on an ad hoc basis, subject to department approval.

D. M. Freeman

Special Subjects

6.901 Inventions and Patents
Engineering School-Wide Elective Subject
(Offered under: 3.172, 6.901, 16.652)
Prereq: 14.02
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-6

See description under subject 3.172. Staff
6.910 Special Studies in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Opportunity for individual study at the undergraduate level related to electrical engineering and computer science not covered by other subjects offered by the department. Student is responsible for initiation of arrangements and filing of proposal. Consult department undergraduate office.
C. J. Terman

6.911–6.914 Special Studies in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
6.915–6.919 Special Advanced Undergraduate Subjects in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Advanced subjects not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
C. J. Terman

6.920 Practical Work Experience
Prereq: None
U (Fall, IAP, Spring, Summer)
0-1-0 [P/D/F]
Can be repeated for credit
For Course 6 students participating in curriculum-related off-campus work experiences in electrical engineering or computer science. Before enrolling, students must have an employment offer from a company or organization and must find an EECS supervisor. Upon completion of the work the student must submit a letter from the employer evaluating the work accomplished, a substantive final report from the student, approved by the MIT supervisor. Subject to departmental approval. Consult Department Undergraduate Office for details on procedures and restrictions.
C. J. Terman

6.921 6-A Internship
Prereq: None
U (Summer)
0-12-0 [P/D/F]
Provides academic credit for the first assignment of 6-A undergraduate students at companies affiliated with the department's 6-A internship program. Enrollment limited to students participating in the 6-A internship program.
M. Zahn

6.922 Advanced 6-A Internship
Prereq: 6.921
U (Spring, Summer)
0-12-0 [P/D/F]
Provides academic credit for the second assignment of 6-A undergraduate students at companies affiliated with the department's 6-A internship program. Enrollment limited to students participating in the 6-A internship program.
M. Zahn

6.923 Pre-Graduate 6-A Internship
Prereq: 6.922
U (Spring, Summer)
0-12-0 [P/D/F]
Provides academic credit for the third assignment of 6-A undergraduate students at companies affiliated with the department's 6-A internship program. Enrollment limited to students participating in the 6-A internship program.
M. Zahn

6.930 Management in Engineering
Engineering School-Wide Elective Subject
(Offered under: 2.96, 6.930, 10.816, 16.862, 22.82, ESD.72)
Prereq: None
U (Fall)
3-1-8
See description under subject 2.96.
H. S. Marcus

6.931 Development of Inventions and Creative Ideas
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Role of the engineer as patent expert and as technical witness in court and patent interference and related proceedings. Rights and obligations of engineers in connection with educational institutions, government, and large and small businesses. Various manners of transplanting inventions into business operations, including development of New England and other US electronics and biotech industries and their different types of institutions.
American systems of incentive to creativity apart from the patent laws in the atomic energy and space fields. Conducting periodic joint real-time class sessions and discussions by video-audio Internet conferencing, with other universities. For graduate students only; others see 6.901. Enrollment limited.
Staff

6.938 Engineering Risk-Benefit Analysis
Engineering School-Wide Elective Subject
(Offered under: 1.155, 2.963, 3.577, 6.938, 10.816, 16.862, 22.82, ESD.72)
Prereq: Calculus II (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.72.
G. E. Apostolakis

6.945 Large-scale Symbolic Systems
Prereq: 6.001, 6.01, 6.034, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Concepts and techniques for the design and implementation of large software systems that can be adapted to uses not anticipated by the designer. Applications include compilers, computer-algebra systems, deductive systems, and some artificial intelligence applications. Means for decoupling goals from strategy. Mechanisms for implementing arbitrary invocation. Work with partially-specified entities. Manage multiple viewpoints. Topics include combinators, generic operations, pattern matching, pattern-directed invocation, rule systems, backtracking, dependencies, indeterminacy, memoization, constraint propagation, and incremental refinement. Comparable programming experience required.
G. J. Sussman

6.946 Classical Mechanics: A Computational Approach
(Same subject as 8.351J, 12.620J)
(Subject meets with 12.008)
Prereq: Physics I (GIR), 18.03, permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit
See description under subject 12.620.
J. Wisdom, G. J. Sussman
6.951 Graduate 6-A Internship
Prereq: 6.921, 6.922, or 6.923
G (Fall, Spring, Summer)
0-12-0 [P/D/F]
Provides academic credit for a graduate assignment of graduate 6-A students at companies affiliated with the department’s 6-A internship program. Enrollment limited to graduate students participating in the 6-A internship program.
M. Zahn

6.952 Graduate 6-A Internship
Prereq: 6.951
G (Fall, Spring, Summer)
0-12-0 [P/D/F]
Provides academic credit for graduate students who require an additional term at the company to complete the graduate assignment of the department’s 6-A internship program. This academic credit is for registration purposes only and cannot be used toward fulfilling the requirements of any degree program. Enrollment limited to graduate students participating in the 6-A internship program.
M. Zahn

6.960 Introductory Research in Electrical Engineering and Computer Science
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Enrollment restricted to first-year graduate students in EECS who are doing introductory research leading to an SM, EE, ECS, PhD, or ScD thesis. Opportunity to become involved in graduate research, under guidance of a staff member, on a problem of mutual interest to student and supervisor. Individual programs subject to approval of professor in charge.
T. P. Orlando

6.961 Introduction to Research in Electrical Engineering and Computer Science
Prereq: Permission of instructor
G (Fall, Spring, Summer)
3-0-0
Seminar on topics related to research leading to an SM, EE, ECS, PhD, or ScD thesis. Limited to first-year regular graduate students in EECS with a fellowship or teaching assistantship.
T. P. Orlando

6.962 Special Studies in Electrical Engineering and Computer Science
Prereq: None
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Opportunity for study of graduate-level topics related to electrical engineering and computer science but not included elsewhere in the curriculum. Registration under this subject normally used for situations involving individual study (under supervision of a faculty member) concerning topics of mutual interest to student and supervisor, but may, when appropriate, be used for small study groups. Normal registration is for 12 units. Registration subject to approval of professor in charge.
T. P. Orlando

6.963–6.969 Special Studies in Electrical Engineering and Computer Science
Prereq: None
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Opportunity for study of graduate-level topics related to electrical engineering and computer science but not included elsewhere in the curriculum. Registration under this subject normally used for situations involving small study groups. Normal registration is for 12 units. Registration subject to approval of professor in charge.
T. P. Orlando

6.971–6.979 Special Subjects in Electrical Engineering and Computer Science
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for group study of advanced subjects related to electrical engineering and computer science not otherwise included in curriculum. Offerings initiated by members of the EECS faculty on an ad hoc basis, subject to department approval.
D. M. Freeman

6.981 Teaching Electrical Engineering and Computer Science
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
For teaching assistants in EECS, in cases where teaching assignment is approved for academic credit by the department.
D. M. Freeman

6.982 Teaching College-Level Science and Engineering
(Same subject as 5.95J, 7.59J, 8.395J, 18.094J)
Prereq: None
G (Spring)
2-0-2 [P/D/F]
See description under subject 5.95J.
L. Breslow

6.985–6.989 Special Subjects in Electrical Engineering
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for group study of advanced subjects related to electrical engineering outside of the curriculum. Offerings initiated by members of the EECS faculty on an ad hoc basis, subject to department approval.
D. M. Freeman

6.991 Research in Electrical Engineering and Computer Science
Prereq: None
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
For EECS MEng students who are research assistants in EECS, in cases where the assigned research is approved for academic credit by the department. Hours arranged with research supervisor.
C. J. Terman

6.999 Practical Experience in EECS
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
For Course 6 students in the SM/PhD track who seek practical off-campus research experiences or internships in electrical engineering or com-
puter science. Before enrolling, students must have a firm employment offer from a company or organization and secure a research supervisor within EECS. Employers required to document the work accomplished. Research proposals subject to departmental approval; consult departmental Graduate Office.

T. P. Orlando

6.CME Study at Cambridge University
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit
Provides credit for students studying at Cambridge University under the Cambridge-MIT Exchange program. Credit may be used to satisfy specific SB degree requirements by arrangement with the department.
D. S. Boning, T. Akinwande

6.EPE UPOP Summer Practice Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 10.EPE, 16.EPE, 22.EPE)
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-1-0 [P/D/F]
Can be repeated for credit
See description under subject 2.EPE.
S. Luperfoy

6.EPR UPOP Reflective Learning Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPR, 2.EPR, 3.EPR, 6.EPR, 10.EPR, 16.EPR, 22.EPR)
Prereq: 2.EPE or permission of instructor
U (Fall)
0-0-3 [P/D/F]
See description under subject 2.EPR.
S. Luperfoy

6.EPW UPOP IAP Workshop
Engineering School-Wide Elective Subject
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW)
Prereq: None
U (IAP)
3-0-0 [P/D/F]
See description under subject 2.EPW.
S. Luperfoy

6.ThG Graduate Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research leading to the writing of an SM, EE, ECS, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member.
T. P. Orlando

6.ThM Master of Engineering Program Thesis
Prereq: 6.UAT
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research leading to the writing of an MEng thesis; to be arranged by the student and an appropriate MIT faculty member. Restricted to MEng students who have been admitted to the MEng program.
C. J. Terman

6.UR Undergraduate Research in Electrical Engineering and Computer Science
Prereq: None
U (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Extended participation in the work of a faculty member or research group, including independent study of the literature, direct involvement in the group's research, and project work under an individual faculty member. Research is arranged by mutual agreement between the student and a member of the EECS faculty, and may continue over several terms. Forms and instructions for the initial letter of intent and final summary report are available in the department undergraduate office.
C. J. Terman
Bachelor of Science in Electrical Science and Engineering/Course 6-1
Bachelor of Science in Electrical Engineering and Computer Science/Course 6-2
Bachelor of Science in Computer Science and Engineering/Course 6-3

General Institute Requirements (GIRs)  Subjects
Science Requirement  6
Humanities, Arts, and Social Sciences Requirement  8
Restricted Electives in Science and Technology (REST) Requirement [satisfied by the mathematics requirement in the Departmental Program]  2
Laboratory Requirement [satisfied by 6.01 and 6.02 together in the Departmental Program]  1
Total GIR Subjects Required for SB Degree  17

Communication Requirement
The program includes a Communication Requirement of 4 subjects:
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program
Subject names below are followed by credit units and by prerequisites, if any (corequisites in italics).

Required Subjects  36
6.01 Introduction to EECS I, 12, 1/2 LAB; Physics II (GIR)
6.02 Introduction to EECS II, 12, 1/2 LAB; 6.01, 18.03*
6.UAT and 6.UAP Undergraduate Advanced Project, 12

Restricted Electives  132–144
1. Two mathematics subjects (also satisfies REST requirement):
(a) Either 18.03 or 18.06 (alternatively 18.700) and
(b) Either 6.041 (alternatively 18.440) or 6.042. Students in Course 6-1 must select 6.041 (or 18.440); students in Course 6-3 must select 6.042.
2. One department laboratory:
One subject selected from the undergraduate laboratory subjects 6.100–6.182 or a departmental list of CS laboratory subjects; students in Course 6-3 must select a CS laboratory subject. Students in Course 6-1 or 6-2 who take both 6.021J and 6.022J may use 6.022J to satisfy the department laboratory requirement.
3. Three/four foundation subjects:
(a) Students in Course 6-1 must take three subjects from the EE foundation list: 6.002, 6.003, 6.004, 6.007.
(b) Students in Course 6-3 must take the three subjects in the CS foundation list: 6.004, 6.005, 6.006.
(c) Students in Course 6-2 must take four subjects from the EECS foundation list (6.002–6.007), with two chosen from the EE foundation list and two from the CS foundation list (6.004 may be counted under either EE or CS).
4. Three header subjects:
(a) Students in Course 6-1 must take three subjects from the EE header list: 6.011, 6.012, 6.013, 6.021J.
(b) Students in Course 6-3 must take the three subjects in the CS header list: 6.033, 6.034, 6.046.
(c) Students in Course 6-2 must take three subjects from the EECS header list (6.011, 6.012, 6.013, 6.021J, 6.033, 6.034, 6.046), with at least one chosen from the EE header list and at least one from the CS header list.
5. Two subjects from a departmental list of advanced undergraduate subjects.
To complete the required Communication-Intensive subjects in the major, students must take one of the following CI-M subjects as a restricted elective in categories 2 or 4 above by the end of the third year: 6.021J, 6.033, 6.101, 6.111, 6.115, 6.121J, 6.131, 6.141, 6.152J, 6.161, 6.182, or 6.805. 6.UAT/6.UAP constitutes the second CI-M.

Departmental Program Units That Also Satisfy the GIRs  (36)
Unrestricted Electives  48
Total Units Beyond the GIRs Required for SB Degree  180–192
No subject can be counted both as part of the 17-subject GIRs and as part of the 180–192 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes
*Alternate prerequisites are listed in the subject descriptions.
For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
# Master of Engineering in Electrical Engineering and Computer Science/Course 6-P

See Notes on Master of Engineering and Bachelor’s Degree Programs (next page)

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement (satisfied by the mathematics requirement in the Departmental Program)</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (satisfied by 6.01 and 6.02 together in the Departmental Program)</td>
<td>1</td>
</tr>
</tbody>
</table>

Total GIR Subjects Required for the SB and MEng Degrees: 17

## Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

## PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

### Required Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.01 Introduction to EECS I, 12, 1/2 LAB; Physics II (GIR)</td>
<td>6</td>
</tr>
<tr>
<td>6.02 Introduction to EECS II, 12, 1/2 LAB; 6.01, 18.03*</td>
<td>12</td>
</tr>
<tr>
<td>6.UAT and 6.UAP Undergraduate Advanced Project, 12</td>
<td>12</td>
</tr>
<tr>
<td>6.ThM MEng Program Thesis, 24**</td>
<td>24</td>
</tr>
</tbody>
</table>

### Restricted Electives

1. Two mathematics subjects (also satisfies REST requirement):
   - Either 18.03 or 18.06 (alternatively 18.700)
   - Alternatively 18.440 or 6.042J or both. Students in Course 6-1 for their bachelor’s degree must select 6.041 (or 18.440); students in Course 6-3 for their bachelor’s degree must select 6.042J.

2. One department laboratory:
   - One subject selected from the undergraduate laboratory subjects 6.100-6.182 or a departmental list of CS laboratory subjects; students in Course 6-3 must select a CS laboratory subject. Students in Course 6-1 or 6-2 who take both 6.021J and 6.022J may use 6.022J to satisfy the department laboratory requirement.

3. Three/four foundation subjects:
   - Students in Course 6-1 must take three subjects from the EE foundation list: 6.002, 6.003, 6.004, 6.007.
   - Students in Course 6-3 must take the three subjects in the CS foundation list: 6.004, 6.005, 6.006.
   - Students in Course 6-2 must take four subjects from the EECS foundation list (6.002-6.007), with two chosen from the EE foundation list and two from the CS foundation list (6.004 may be counted under either EE or CS).

4. Three header subjects:
   - Students in Course 6-1 must take three subjects from the EE header list: 6.011, 6.012, 6.013, 6.021J.
   - Students in Course 6-3 must take the three subjects in the CS header list: 6.033, 6.034, 6.046.
   - Students in Course 6-2 must take three subjects from the EECS header list: 6.011, 6.012, 6.013, 6.021J, 6.033, 6.034, 6.046, with at least one chosen from the EE header list and at least one from the CS header list.

5. Two subjects from a departmental list of advanced undergraduate subjects.

6. Four H-level graduate subjects totaling at least 42 units, of which at least 36 units must come from subjects taken within the department.

7. Two subjects from a restricted departmental list of mathematics, science, and engineering electives.

To complete the required Communication-Intensive subjects in the major, students must take one of the following CI-M subjects as a restricted elective in categories 2 or 4 above by the end of the third year: 6.021J, 6.033, 6.101, 6.111, 6.115, 6.121J, 6.131, 6.141, 6.152J, 6.161, 6.182, or 6.805. 6.UAT/6.UAP constitutes the second CI-M.

### Departmental Program Units That Also Satisfy the GIRs

<table>
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<tr>
<th>Units</th>
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<td>(36)</td>
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### Unrestricted Electives

<table>
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<th>Units</th>
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<td>48</td>
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Total Units Beyond the GIRs Required for Simultaneous Award of the MEng and SB Degrees: 270–282

No subject can be counted both as part of the 17-subject GIRs and as part of the 270–282 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

### Notes

*Alternate prerequisites are listed in the subject description.

**6-PA Program requires performance of thesis at company location.
Notes on Master of Engineering and Bachelor's Degree Programs

The Master of Engineering program builds on the bachelor's degree program selected by the student (6-1, 6-2, or 6-3), with restricted elective categories 6 and 7 and the MEng thesis (6.ThM).

The subjects required under restricted elective category 6 are selected with departmental review and approval to ensure that the combination of these with the two advanced undergraduate subjects under restricted elective category 5 includes at least 36 units in a distinct and appropriate area of graduate concentration.

The Master of Engineering in Electrical Engineering and Computer Science is only awarded to students who have received, or are simultaneously receiving, one of the three bachelor's degrees. Students who receive the Master of Engineering degree after having obtained one of the three bachelor's degrees must fulfill the requirements for Course 6-P as described above.

For further details on all EECS programs, visit http://www.eecs.mit.edu/acad.html.

For an explanation of credit units, or hours, please refer to the online help in the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
7.02 Introduction to Experimental Biology and Communication
(Subject meets with 10.702)
Prereq: Biology (GIR)
U (Fall, Spring)
4-0-8 REST

7.03 Genetics
Prereq: Biology (GIR)
U (Fall, Spring)
4-0-8 REST

7.05 General Biochemistry
Prereq: 5.12, Biology (GIR), or permission of instructor
U (Spring)
5-0-7 REST

7.06 Cell Biology
Prereq: 7.03, 7.05
U (Fall, Spring)
4-0-8

7.08J Biological Chemistry II
(Subject meets with 5.08J)
Prereq: 5.12; 5.07 or 7.05
U (Spring)
4-0-8

7.10J Physical Chemistry of Biomolecular Systems
(Subject meets as 20.111)
Prereq: Calculus II (GIR), Chemistry (GIR), Physics I (GIR); Coreq: Physics II (GIR)
U (Spring)
5-0-7

Credit cannot also be received for 20.110

Provides a quantitative approach to understanding the physical and chemical laws that govern the behavior of biological macromolecules. Basic thermodynamics, state of a system, state variables. Work, heat, first, second, and third laws of thermodynamics. Entropy and its statistical basis, free energy representations, Legendre transforms, Maxwell relations, Gibbs function, Boltzmann distribution and partition functions. Equilibrium properties of macroscopic and microscopic systems; macromolecular structure and interactions in solution. Driving forces for molecular self-assembly. Binding, cooperativity, solvation, and titration of macromolecules. Applications of introductory quantum mechanics to spectroscopy.

Staff
underlie the cellular response to pathogens. Other projects will examine the genes that control a cell’s response to chemotherapy. Cytotoxic drugs to help understand the pathways execution of cellular responses. Some projects experiments to address questions regarding two or three students will design and carry out pro-survival and pro-death pathways. Teams of will be used to examine the genetics of cellular analysis, and massively parallel sequencing interference (RNAi) screening, microarray expression studies. Instruction and practice in written and oral communication are also emphasized. Enrollment limited. M. Laub, D. Newman

7.16 Experimental Molecular Biology: Biotechnology II Prereq: 7.02, 7.03, 7.05 U (Spring) 4-16-10

Applies emerging high-throughput genetic approaches to study the response of mammalian cells to cytotoxic or infectious stimuli. RNA interference (RNAi) screening, microarray expression analysis, and massively parallel sequencing will be used to examine the genetics of cellular pro-survival and pro-death pathways. Teams of two or three students will design and carry out experiments to address questions regarding the mechanisms that govern the regulation and execution of cellular responses. Some projects involve the use of DNA damaging agents or other cytotoxic drugs to help understand the pathways that control a cell’s response to chemotherapy. Other projects will examine the genes that underlie the cellular response to pathogens.

Instruction and practice in written and oral communication provided.
M. Hemann, J. Saeij

7.17 Experimental Molecular Biology: Biotechnology III Prereq: 7.02, 7.03, 7.05 U (Spring) 4-16-10

Cell and molecular biology lab that uses recombinant DNA methods and optical microscopy to study cellular mechanisms in eukaryotic cells. Projects focus on mechanisms of intracellular protein translocation and cytoskeletal rearrangement. Students explore the recombinant fluorescent proteins using imaging techniques and describe the effects of the expressed protein on cell motility, the cell cycle, or the organization and function of cytoplasmic organelles and the cytoskeleton. Projects involve many techniques, such as DNA sequence analysis, RNAi, RT-PCR, and Western blotting. Instruction and practice in written and oral communication provided.
F. Gertler, M. L. Pardue

7.18 Topics in Experimental Biology Prereq: 7.02, 7.03, 7.05 U (Fall, Spring) 4-16-10

Credit cannot also be received for 7.19

Independent experimental study under the direction of a member of the Biology Department faculty. Allows students with a strong interest in independent research to fulfill the project laboratory requirement for the Biology Department Program in the context of a research laboratory at MIT. The research should be a continuation of a previous project. Written and oral presentation of the research results is required. Journal club discussions are used to help students evaluate and write scientific papers. Instruction and practice in written and oral communication is provided. Permission of the faculty research supervisor and the Biology Education Office must be obtained in advance.

Fall: M. L. Pardue, A. J. Sinskey
Spring: S. Lindquist, N. Hopkins

7.19 Communication in Experimental Biology Prereq: 7.02, 7.03, 7.05 U (Fall, Spring) 4-4-4

Credit cannot also be received for 7.18

Students carry out independent literature research. Meets with the seminar and writing tutorial portions of 7.18. Journal club discussions are used to help students evaluate and write scientific papers. Instruction and practice in written and oral communication is provided. Permission of the instructor and the Biology Education Office must be obtained in advance.
Fall: M. L. Pardue, A. J. Sinskey
Spring: S. Lindquist, N. Hopkins

7.20] Human Physiology (Same subject as HST.540)
Prereq: 7.05 U (Fall) 5-0-7

Comprehensive subject in human physiology, emphasizing the molecular basis and applied aspects of organ function and regulation in health and disease. Includes a review of cell structure and function, as well as the mechanisms by which the endocrine and nervous systems integrate cellular metabolism. Special emphasis on examining the cardiovascular, pulmonary, gastrointestinal, and renal systems. M. Krieger, D. Sabatini

7.21 Microbial Physiology (Subject meets with 7.62)
Prereq: 7.03, 7.05 U (Fall) 4-0-8

Biochemical properties of bacteria and other microorganisms that enable them to grow under a variety of conditions. Interaction between bacteria and bacteriophages. Genetic and metabolic regulation of enzyme action and enzyme formation. Structure and function of components of the bacterial cell envelope. Protein secretion with a special emphasis on its various roles in pathogenesis. Additional topics include bioenergetics, symbiosis, quorum sensing, global responses to DNA damage, and biofilms. Students taking the graduate version are expected to explore the subject in greater depth.
G. C. Walker, B. Magasanik, D. Newman

7.22 Development and Evolution Prereq: 7.03, 7.06 U (Fall) 5-0-7

Covers animal development and evolution. Topics include origins of multicellularity, the germline, formation of early body plans, cell type determination, organogenesis, morphogenesis, stem cells, cloning, evolution of developmental diversity and processes, developmental genetics, and issues in human development. Experimental approaches to problems of development and evolution, including the study of vertebrate (mouse, chick, frog, fish) and invertebrate (fly, worm) models, will be covered.
M. Constantine-Paton, P. Reddien
7.23 Immunology
(Subject meets with 7.63)
Prereq: 7.03, 7.05, 7.06, or permission of instructor
U (Spring)
5-0-7
A comprehensive survey of molecular, genetic, and cellular aspects of the immune system.
Topics include innate and adaptive immunity; cells and organs of the immune system; immunoglobulin, T cell receptor, and major histocompatibility complex (MHC) genes and structure; development and functions of B and T lymphocytes; immune responses to infections and tumors; hypersensitivity, autoimmunity, and immunodeficiencies. Particular attention is paid to the development and function of the immune system as a whole as studied by modern methods and techniques.
H. Ploegh, L. Steiner

7.24 The Protein Folding Problem
Prereq: 7.05 or 5.07
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
4-2-6
Mechanisms by which the amino acid sequence of polypeptide chains determines their three-dimensional conformation. Topics include: sequence determinants of secondary structure; folding of newly synthesized polypeptide chains within cells; unfolding and refolding of proteins in vitro; folding intermediates aggregation and competing off-pathway reactions; role of chaperonins, isomerases, and other helper proteins; protein recovery problems in the biotechnology industry; diseases associated with protein folding defects.
J. A. King

7.25 Biological Regulatory Mechanisms
Prereq: 7.02, 7.03, 7.05
U (Spring)
4-0-8
Cells utilize a variety of mechanisms to regulate gene expression, growth, development, and behavior in response to both external and internal conditions. Examines basic principles of biological regulation, focusing on several well-studied examples, usually drawn from microbial species. Reading includes primary literature and review articles with emphasis on how we know what we know, and how to think experimentally.
B. Magasanik, U. RajBhandary

7.26 Molecular Basis of Infectious Disease (New)
(Subject meets with 7.66)
Prereq: 7.03, 7.05, 7.06
U (Spring)
4-0-8
Focuses on the principles of host-pathogen interactions with an emphasis on infectious diseases of humans. Presents key concepts of pathogenesis through the study of various human pathogens. Lectures accompanied by readings that illustrate modern experimental molecular methodologies. Students taking graduate version complete additional assignments.
D. Kim, J. Saeij

7.27 Principles of Human Disease
Prereq: 7.03, 7.05, 7.06
U (Spring)
4-0-8
Covers current understanding of and modern approaches to human disease, emphasizing the molecular and cellular basis of both genetic disease and cancer. Topics include the genetics of simple and complex traits; karyotypic analysis and positional cloning; genetic diagnosis; the roles of oncogenes and tumor suppressors in tumor initiation, progression, and treatment; the interaction between genetics and environment; animal models of human disease; cancer; and conventional and gene therapy treatment strategies.
D. Housman, L. Guarente

7.28 Molecular Biology
(Subject meets with 7.58)
Prereq: 7.03; Coreq: 7.05
U (Spring)
5-0-7
Detailed analysis of the biochemical mechanisms that control the maintenance, expression, and evolution of prokaryotic and eukaryotic genomes. Topics covered in lecture and readings of relevant literature include: gene regulation, DNA replication, genetic recombination, and mRNA translation. Logic of experimental design and data analysis emphasized. Presentations include both lectures and group discussions of representative papers from the literature. Students taking the graduate version are expected to explore the subject in greater depth.
T. Baker, S. Bell

7.29] Cellular Neurobiology
(Subject meets as 9.09)
Prereq: 7.05
U (Spring)
4-0-8
Introduction to the structure and function of the nervous system. Emphasizes the cellular properties of neurons and other excitable cells. Includes the structure and biophysical properties of excitable cells, synaptic transmission, neurochemistry, neurodevelopment, integration of information in simple systems, and detection and information coding during sensory transduction.
W. G. Quinn, J. T. Littleton

7.30] Ecology I: The Earth System
(Subject meets as 1.018J)
Prereq: None
U (Fall)
3-1-8 REST
See description under subject 1.018J.
S. W. Chisholm, E. Delong

7.31 Current Topics in Mammalian Biology: Medical Implications
Prereq: 7.05, 7.06, or permission of instructor
U (Fall)
4-0-8
Covers recent advances in mammalian cell and developmental biology with particular emphasis on approaches that utilize mouse genetics. Combines formal lectures on selected topics with readings of original papers which are discussed in class. Major emphasis on the implications of mechanisms of human genetic diseases. Topics include early mammalian development; genomic imprinting; X inactivation; embryonic stem cells; nuclear reprogramming of somatic cells; cell migration; nervous system development; and central nervous system degenerative diseases such as Alzheimer’s and Huntington’s disease. Enrollment limited to 20.
F. Gertler, R. Jaenisch

7.32 Systems Biology
(Subject meets with 7.81J, 8.591J)
Prereq: permission of instructor
U (Fall)
3-0-9
Topics include molecular, cellular, and developmental systems biology. Molecular systems component covers constructing and modeling of genetic networks, control theory and genetic networks, lambda phage as a genetic switch, synthetic genetic switches, bacterial chemotaxis, genetic oscillators, and circadian rhythms. Cellular systems includes reaction diffusion
equations, local activation and global inhibition models, gradient sensing systems, and center-finding networks. Developmental systems covers general pattern formation models, modeling cell-cell communication, quorum sensing, and models for Drosophila development. Students taking the graduate version explore the subject in more depth.

A. Van Oudenaarden

7.340–7.349 Advanced Undergraduate Seminars
Prereq: 7.03, 7.05, 7.06, or 7.28
U (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit

Seminars covering topics of current interest in biology with a focus on how to understand experimental methods and design and how to critically read the primary research literature. Small class size facilitates discussions and interactions with an active research scientist. Students visit research laboratories to see firsthand how biological research is done. Contact Biology Education Office for topics.

H. R. Horvitz

7.35 Topics in Metabolic Biochemistry
(Subject meets with 5.77, 7.75i)
Prereq: 7.05 or 5.07
U (Fall)
4-0-8

Topics include major metabolic pathways for the biosynthesis of certain cellular constituents and oxidative metabolism. Emphasizes enzymology and methods used to understand metabolism and enzymatic processes.

G. M. Brown

7.36 Foundations of Computational and Systems Biology
(Subject meets with 7.91, 20.390, 20.490i)
Prereq: Biology (GIR); 7.05 or 5.07; 1.00, 1.001, or 6.00; or permission of instructor
U (Spring)
3-0-9

Introduction to computational and systems biology emphasizing fundamentals of nucleic acid, protein sequence, and structural analysis, as well as the analysis of complex biological systems. Principles and methods used for sequence alignment, motif finding, expression array analysis, structural modeling, structure design and prediction, and network analysis and modeling. Techniques include dynamic programming, Markov and hidden Markov models, Bayesian networks, clustering methods, and energy minimization approaches. Exposure to emerging research areas. Designed for graduate students and advanced undergraduates with strong backgrounds in either molecular biology or computer science. Some foundational material covering basic programming skills, probability and statistics is provided for students with less quantitative backgrounds.

C. Burge, E. Fraenkel, A. Keating

7.37 Molecular and Engineering Aspects of Biotechnology
(Same subject as 10.441i, 20.361i)
Prereq: 20.110i, 20.05, 3.012, or 5.60; 7.06; or permission of instructor
U (Spring)
4-0-8

Biological and bioengineering principles underlying the development and use of recombinant proteins as therapeutic drugs; fundamentals of therapeutic protein action, including cell-cell and cell-matrix interactions and intracellular signaling pathways; classes of protein therapeutics; post-translational processing and secretion of proteins; gene cloning and expression in mammalian cells; physiology of cell growth and in vitro cultivation; site-specific mutation of proteins; protein pharmacology and delivery.

H. Lodish, L. G. Griffith

7.39 Selected Topics in Biology for Undergraduates
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit

Program of study or research to be arranged with a Department faculty member. Written report required. Consult Biology Education Office.

Staff

7.391 Special Topics in Biology for Undergraduates
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

7.392 Special Topics in Biology for Undergraduates
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Topics of current or special interest.

Staff

7.40 Biotechnology: Engineering of Macromolecules
Prereq: 7.05
U (Spring)
3-0-6

Fundamentals of genetics and biochemical principles for the synthesis, design, engineering, and application of biopolymers such as polyesters and polysaccharides. Principles underlying structure-function properties of biopolymers. Topics include conformation, image, and nanostructure analysis; behavior of polymers in solution; structure, topography, and functional performance of biopolymers; and biopolymer complexes and assemblies.

C. K. Rha, A. J. Sinskey

7.UR Undergraduate Research
Prereq: Permission of department.
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

7.URG Undergraduate Research
Prereq: Permission of department
U (Fall, Spring)
Units arranged
Can be repeated for credit

Undergraduate research opportunities in the Department of Biology. For further information, consult departmental coordinator, Gene Brown.

Staff

GRADUATE SUBJECTS

MIT-WHOI Joint Program in Oceanography

7.410 Applied Statistics
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Applied statistics covers probability and distributions (normal binomial, poisson, exponential, lognormal, and uniform), estimation and hypothesis testing, parametric and nonparametric one-sample and two-sample tests of means, analysis of variance for crossed and nested designs, linear and multiple regression with residual analysis, correlation and discrete data analysis using chi-squared tests. Discussion of experimental and sampling designs are included. Examples use data from biological studies.

V. Starczak (WHOI)
7.411–7.419 Seminars in Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Selected topics in biological oceanography.
*Information: J. Waterbury (WHOI)*

7.421 Special Problems in Biological Oceanography
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Advanced problems in biological oceanography with assigned reading and consultation.
*Information: J. Waterbury (WHOI)*

7.430 Topics in Quantitative Marine Science
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussions on quantitative marine ecology. Topics vary from year to year.
*A. Solow, M. Neubert (WHOI)*

7.431 Topics in Marine Ecology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussions on ecological principles and processes in marine populations, communities, and ecosystems. Topics vary from year to year.
*H. Caswell, R. Harbison (WHOI)*

7.432 Topics in Marine Physiology and Biochemistry
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussions on physiological and biochemical processes in marine organisms. Topics vary from year to year.
*M. Hahn, J. McDowell, J. Stegeman (WHOI)*

7.433 Topics in Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussions on biological oceanography. Topics vary from year to year.
*R. Gast (WHOI)*

7.434 Topics in Zooplankton Biology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussions on the biology of marine zooplankton. Topics vary from year to year.
*L. Madin, R. Harbison (WHOI)*

7.435 Topics in Benthic Biology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussions on the biology of marine benthos. Topics vary from year to year.
*L. Mullineaux, R. Scheltema, T. Shank (WHOI)*

7.436 Topics in Phytoplankton Biology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussion on the biology of marine phytoplankton. Topics vary from year to year.
*R. Olson, H. Sosik, D. Anderson, S. Dyhrman (WHOI)*

7.437 Topics in Molecular Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussion on molecular biological oceanography. Topics vary from year to year.
*M. Hahn, T. Shank, R. Gast, D. Anderson, S. Sievert (WHOI)*

7.438 Topics in the Behavior of Marine Animals
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussion on the behavioral biology of marine animals. Topics vary from year to year.
*R. Tyack, M. Moore (WHOI)*

7.439 Topics in Marine Microbiology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussion on the biology of marine prokaryotes. Topics vary from year to year.
*J. Waterbury, S. Sievert, E. Webb (WHOI)*

7.440 An Introduction to Mathematical Ecology
Prereq: Calculus I (GIR), 1.018J, or permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit
Covers the basic models of population growth, demography, population interaction (competition, predation, mutualism), food webs, harvesting, and infectious disease, and the mathematical tools required for their analysis. Because these tools are also basic to the analysis of models in biochemistry, physiology, and behavior, subject also broadly relevant to students whose interests are not limited to ecological problems.
*M. Neubert, H. Caswell (WHOI)*

7.47 Biological Oceanography
Prereq: Advanced training in biology
G (Spring)
3-0-9 H-LEVEL Grad Credit
Intensive overview of biological oceanography. Major paradigms discussed, and dependence of biological processes in the ocean on physical and chemical aspects of the environment examined. Surveys the diversity of marine habitats, major groups of taxa inhabiting those habitats, and the general biology of the various taxa: the production and consumption of organic material in the ocean, as well as factors controlling those processes. Species diversity, structure of marine food webs, and the flow of energy within different marine habitats are detailed and contrasted.
*L. Mullineaux, H. Sosik, J. Pineda, S. Dyhrman, E. Webb (WHOI)*
microbiology (MICRO)

7.492 Methods and Problems in Microbiology
(Same subject as 1.86J, 20.445J)
Prereq: permission of instructor or Coreq: 7.493
G (Fall)
3-0-9 [P/D/F] H-LEVEL Grad Credit

Students will read and discuss primary literature covering key areas of microbial research with emphasis on methods and approaches used to understand and manipulate microbes. Limited to students in the microbiology program.
L. Samson, M. Polz

7.493 Microbial Genetics and Evolution
(Same subject as 1.87J, 20.446J)
Prereq: 7.03, 7.05, 7.28 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

Covers aspects of microbial genetic and genomic analyses, central dogma, horizontal gene transfer, and evolution.
A. D. Grossman, E. Alm

7.499 Research Rotations in Microbiology
Prereq: Permission of instructor; Coreq: 7.492, or 7.493
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Introduction to faculty participating in the interdepartmental Microbiology graduate program and a series of lab rotations. During the first year, students will rotate through three labs of MIT faculty that participate in the Microbiology graduate program. These rotations will help provide students a broad exposure to microbiology research and will be used to select a lab for their thesis research by the end of the first year. Given the interdisciplinary nature of the program, and many research programs, students may be able to work jointly with more than one research supervisor. Limited to students in the microbiology program.

7.50 Method and Logic in Molecular Biology
Prereq: Permission of instructor or Coreq: 7.51 and 7.52
G (Fall)
4-0-8 H-LEVEL Grad Credit

Logic and experimental design: an in-depth discussion and assessment of biochemical, physical, genetic, and cell biological methods employed in testing hypotheses. Limited to Course 7 graduate students.

7.51 Principles of Biochemical Analysis
Prereq: Permission of instructor
G (Fall)
6-0-6 H-LEVEL Grad Credit

Fundamental principles of biochemistry. Analysis of the structure and mechanism of catalytic and regulatory macromolecules.
R. T. Sauer, F. Solomon, I. Cheeseman

7.52 Genetics for Graduate Students
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

Principles and approaches of genetic analysis, including Mendelian inheritance and prokaryotic genetics, developmental genetics, neurogenetics, human genetics, and epigenetics. Recitation and problem sets supplement lectures.
H. R. Horvitz, D. Housman, A. Amon

7.540 Frontiers in Chemical Biology
(Same subject as 5.54J, 20.554J)
Prereq: 5.13, 5.07, 7.06, permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

See description under subject 5.54J.
S. Bell, F. Solomon, P. Chang

7.541 Principles and Practice of Drug Development
(Same subject as 10.541J, 15.136J, ESD.691J, HST.920J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

See description under subject 15.136J,
T. J. Allen, C. L. Cooney, S. N. Finkelstein, R. H. Rubin, A. J. Sinskey

7.548 Perspectives in Biological Engineering
(Same subject as 20.400J)
Prereq: Permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit

See description under subject 20.400J.
F. White, E. Fraenkel

7.549 Case Studies and Strategies in Drug Discovery and Development
(Same subject as 15.137J, 20.486J, HST.916J)
Prereq: Permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit

See description under subject 20.486J.
S. R. Tannenbaum, A. J. Sinskey, E. Berndt

7.554 Foundations of Cell Biology
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
5-0-7 H-LEVEL Grad Credit

Designed for graduate students interested in understanding biological processes at the cellular level, this course serves biologists working in a wide range of areas and provides the foundation to approach the current literature. The goals are to discuss fundamental topics in cell and molecular biology; demonstrate how the major questions have been approached, technically and intellectually; analyze how one interprets the data produced by those approaches; and identify the questions that remain. Topics include macromolecular synthesis, assembly of cellular complexes and structures, control of cell division, and cell signaling. Familiarity with the basics of biochemistry and genetics is assumed.
S. Bell, F. Solomon, P. Chang

7.57 Quantitative Biology for Graduate Students
Prereq: Permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit

Introduces the fundamental concepts and tools of quantitative approaches to molecular and cellular biology. Covers a wide range of mathemati-
7.58 Molecular Biology
(Subject meets with 7.28)
Prereq: 7.03; 7.05
G (Spring)
5-0-7 H-LEVEL Grad Credit
Detailed analysis of the biochemical mechanisms that control the maintenance, expression, and evolution of prokaryotic and eukaryotic genomes. Topics covered in lecture and readings of relevant literature include: gene regulation, DNA replication, genetic recombination, and mRNA translation. Logic of experimental design and data analysis emphasized. Presentations include both lectures and group discussions of representative papers from the literature. Students taking the graduate version are expected to explore the subject in greater depth.
T. Baker, S. Bell

7.59 Teaching College-Level Science and Engineering
(Same subject as 5.95J, 6.982J, 8.395J, 18.094J)
Prereq: None
G (Spring)
2-0-2 [P/D/F]
See description under subject 5.95J.
L. Breslow

7.60 Cell Biology: Structure and Functions of the Nucleus
Prereq: 7.06
G (Spring)
4-0-8 H-LEVEL Grad Credit
Eukaryotic genome structure, function, and expression, processing of RNA, and regulation of the cell cycle. Emphasis on the techniques and logic used to address important problems in nuclear cell biology. Lectures on broad topic areas in nuclear cell biology and discussions on representative recent papers.
P. Sharp, R. Young

7.61 Eukaryotic Cell Biology: Principles and Practice
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Emphasizes methods and logic used to analyze eukaryotic cells in diverse systems (e.g., yeast, fly, worm, mouse, human; development, neurons). Subject combines lectures and in-depth roundtable discussions of literature readings with active participation of faculty experts. Focuses on membranes, organelles, the cell surface, cytoskeleton and extracellular matrix. Topics include membrane protein structure, cell surface receptors and transporters; signal transduction pathways; membrane trafficking / sorting / secretion; adhesion and its effects on organization, migration and polarity of cells; regulation of the cell cycle; integration of cells into tissues and organs. Ranges from basic studies to applications to human disease, while emphasizing critical analysis of experimental approaches. Limited enrollment.
M. Krieger

7.62 Microbial Physiology
(Subject meets with 7.21)
Prereq: 7.03, 7.05
G (Fall)
4-0-8 H-LEVEL Grad Credit
Biochemical properties of bacteria and other microorganisms that enable them to grow under a variety of conditions. Interaction between bacteria and bacteriophages. Genetic and metabolic regulation of enzyme action and enzyme formation. Structure and function of components of the bacterial cell envelope. Protein secretion with a special emphasis on its various roles in pathogenesis. Additional topics include bioenergetics, symbiosis, quorum sensing, viral responses to DNA damage, and biofilms. Students taking the graduate version are expected to explore the subject in greater depth.
G. C. Walker, B. Magasanik, D. Newman

7.63 Immunology
(Subject meets with 7.23)
Prereq: Permission of instructor
G (Spring)
5-0-7 H-LEVEL Grad Credit
A comprehensive survey of molecular, genetic, and cellular aspects of the immune system. Topics include innate and adaptive immunity; cells and organs of the immune system; immunoglobulin, T cell receptor, and major histocompatibility complex (MHC) genes and structure; development and functions of B and T lymphocytes; immune responses to infections and tumors; hypersensitivity, autoimmunity, and immunodeficiencies. Particular attention is paid to the development and function of the immune system as a whole as studied by modern methods and techniques.
H. Ploegh, L. Steiner

7.66 Molecular Basis of Infectious Disease (New)
(Subject meets with 7.26)
Prereq: 7.03, 7.05, 7.06
G (Spring)
4-0-8 H-LEVEL Grad Credit
Focuses on the principles of host-pathogen interactions with an emphasis on infectious diseases of humans. Presents key concepts of pathogenesis through the study of various human pathogens. Lectures accompanied by readings that illustrate modern experimental molecular methodologies. Students taking graduate version complete additional assignments.
D. Kim, J. Saeij

7.67J Genetic Neurobiology
(Same subject as 9.322J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject 9.322J.
W. G. Quinn, J. T. Littleton

7.68J Cellular and Molecular Neurobiology
(Same subject as 9.013J)
Prereq: 9.011 or permission of instructor
G (Spring)
6-0-12 H-LEVEL Grad Credit
See description under subject 9.013J.
M. Constantine-Paton, L.-H. Tsai, W. Quinn

7.69J Developmental Neurobiology
(Same subject as 9.181J)
(Subject meets with 9.18)
Prereq: 9.011 or permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
4-0-8 H-LEVEL Grad Credit
See description under subject 9.181J.
E. Nedivi

7.70 Regulation of Gene Expression
Prereq: Permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
Cells utilize a variety of mechanisms to regulate gene expression, growth, development, and behavior in response to both external and internal conditions. Seminar examines basic principles of biological regulation and focuses on examples that underpin the principles, as well as those that challenge certain long-held views. Enrollment limited to 40.
L. Boyer, G. Fink
7.71 Biophysical Chemistry Techniques
(Subject meets with 5.78)
Prereq: 5.13, 5.60; 5.07 or 7.05
G (Spring)
5-0-7

For students who want to understand the benefits and caveats of biophysical techniques used to ascertain the structure of macromolecules, especially on the 3-D level. The first half of the course focuses on x-ray crystallography, the single most important technique used in determining the 3-D structure of macromolecules. Discussion of crystallographic theory is complemented with exercises such as crystallization, data processing, and model building. In the second half of the course, biophysical techniques are covered that supplement the 3-D characterization of biological macromolecules. Topics include CD spectroscopy, isothermal calorimetry, analytical ultracentrifugation, dynamic light scattering, and surface plasmon resonance (BLI/core). Theoretical principles behind the techniques are covered, applications are discussed, and students are performing practical exercises using instrumentation available at MIT.

C. Drennan, T. Schwartz

7.72 Development and Evolution
Prereq: Permission of instructor
G (Fall)
5-0-7

Lectures and literature discussion cover animal development and evolution. Focus on molecular mechanisms, experimental approaches, and relevant disorders. Comparison of vertebrate (mouse, chick, frog, fish) and invertebrate (fly, worm) models. Topics include the early body plan, cell type determination and diversity, organogenesis, morphogenesis, stem cells, cloning, and issues in human development.

H. Sive, T. Orr-Weaver

7.75 Topics in Metabolic Biochemistry
(Subject meets with 5.77i)
Prereq: 7.05 or 5.07
G (Fall)
4-0-8 H-LEVEL Grad Credit

Topics include major metabolic pathways for the biosynthesis of certain cellular constituents and oxidative metabolism. Emphasis is on enzymology and methods used to understand metabolism and enzymatic processes.

G. M. Brown

7.76 Topics in Protein Biochemistry
Prereq: Permission of instructor
G (Spring)
2-0-7

In-depth analysis and discussion of classic and current literature, with an emphasis on protein structure and function. Topics include binding specificity; cooperativity and allostery; protein folding and misfolding; macromolecular assembly; sequence homology and prediction of structure; and protein engineering and design. Undergraduates should have taken 7.71 or 5.64.

A. Keating, R. T. Sauer

7.77 Nucleic Acids, Structure, Function, Evolution and Their Interactions with Proteins
Prereq: 7.05 or 7.51
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Lectures, analysis, and discussion of current literature, student presentations. Biochemical, biophysical, and genetic approaches to understanding nucleic acids. General properties, functions, and structural motifs of DNA and RNA. DNAs and RNAs as catalysts. Interaction of nucleic acids with proteins such as repressors, restriction and modification enzymes, aminocyl-tRNA synthetases and other proteins of the translational machinery. RNA protein recognition. Selection and engineering approaches for generating nucleic acid molecules with novel catalytic and binding properties.

D. Bartel, U. RajBhandary

7.80 Biological Chemistry II
(Subject meets with 5.08i, 7.08i)
Prereq: 5.12; 5.07 or 7.05
G (Spring)
4-0-8 H-LEVEL Grad Credit

More advanced treatment of biochemical mechanisms that underlie biological processes. Topics include macromolecular machines such as the ribosome, the proteosome, fatty acid synthases as a paradigm for polyketide synthases and non-ribosomal polypeptide synthases, and polymerses. Emphasis is on experimental methods used to unravel these processes and how these processes fit into the cellular context and coordinate regulation. Students taking the graduate version are expected to explore the subject in greater depth.

A. Y. Ting

7.81 Systems Biology
(Subject meets with 7.32)
Prereq: None
G (Fall)
3-0-9

See description under subject 8.591J.

A. Van Oudenaarden

7.82 Topics of Mammalian Development and Genetics
Prereq: None
G (Spring)
3-0-9 [P/D/F]

Seminar covering embryologic, molecular, and genetic approaches to development in mice and humans. Topics include preimplantation development; gastrulation; embryonic stem cells, gene targeting and nuclear cloning; genomic imprinting; X-inactivation; sex determination; germ cells; association and linkage analysis.

R. Jaenisch, D. Page

7.88j Protein Folding and Human Disease
(Subject meets as 5.48j, 10.543j)
Prereq: 7.51 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

Many chronic human diseases are associated with misfolding or aggregation of particular proteins or their fragments. Notable examples include Alzheimer’s disease, Parkinson’s disease, Huntington’s disease, bovine spongiform encephalopathy (mad cow disease), human prion diseases, and light chain amyloidosis. Covers the underlying protein and cell biochemistry, including folding of newly synthesized polypeptide chains within cells; unfolding and refolding of proteins in vitro; folding intermediates, aggregation, and competing off-pathway reactions; amyloid fibril structure and polymerization; amyloids that produce biofilms, pigments, and other functional structures; roles of chaperonins, isomerases, and other helper proteins. Examines key model systems, including yeast, nematodes, flies and mice, as well as human pathologies and phenotypes.

S. Lindquist, J. A. King

7.89j Topics in Computational and Systems Biology
(Subject meets as CSB.100j)
Prereq: Permission of instructor
G (Fall)
2-0-10 H-LEVEL Grad Credit

See description under subject CSB.100j.

C. Burge
7.91J Foundations of Computational and Systems Biology
(Same subject as 20.490J)
(Subject meets with 7.36, 20.390)
Prereq: Biology (GIR); 7.05 or 5.07; 1.00, 1.001, or 6.00; or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Introduction to computational and systems biology emphasizing fundamentals of nucleic acid, protein sequence, and structural analysis, as well as the analysis of complex biological systems. Principles and methods used for sequence alignment, motif finding, expression array analysis, structural modeling, structure design and prediction, and network analysis and modeling. Techniques include dynamic programming, Markov and hidden Markov models, Bayesian networks, clustering methods, dead-end elimination and energy minimization approaches. Exposure to emerging research areas. Designed for graduate students and advanced undergraduates with strong backgrounds in either molecular biology or computer science. Some foundational material covering basic programming skills, probability and statistics is provided for students with less quantitative backgrounds.

C. Burge, A. Keating

7.92J Molecular Pathology and Cognitive Sequelae of Age-dependent Neurological Disease
(Same subject as 9.110J)
Prereq: 9.011, 9.013, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 9.110J.
S. Corkin, L.-H. Tsai

7.93 Selected Topics in Biology for Graduate Students
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Classwork in various fields of biology not covered by the regular subjects of instruction.

7.931 Special Topics in Biology for Graduate Students
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

7.932 Special Topics in Biology for Graduate Students
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Topics of current or special interest.

Staff

7.941 Research Problems
Prereq: None
G (Fall)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

7.942 Research Problems
Prereq: None
G (Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Directed research in a field of biological science, but not contributory to graduate thesis.

Consult Biology Education Office

7.95 Cancer Biology
Prereq: 7.03, 7.06
G (Spring)
3-0-9 H-LEVEL Grad Credit

Intensive analysis of historical and current developments in cancer biology. Topics include principles of transformation, viral and cellular oncogenes, tumor suppressor genes, tumor-cell growth, apoptosis, principles of cancer biology, and cancer genetics. Detailed analyses of the current research literature including important research reports published in recent years. Limited enrollment.

J. Lees, R. Weinberg, M. Hemann

7.98J Neural Plasticity in Learning and Memory
(Same subject as 9.301J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject 9.301J.

S. Tonegawa, M. Bear, W. Quinn, M. Wilson

7.9H Graduate Biology Thesis
Prereq: None
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Program of research leading to the writing of a PhD thesis; to be arranged by the student and an appropriate MIT faculty member.

Staff
### Bachelor of Science in Biology/Course 7

**General Institute Requirements (GIRs)**

| Subjects |  
| --- | --- |
| Science Requirement [two subjects can be satisfied by 5.111, 5.112, or 3.091, and 7.012, 7.013, or 7.014 in the Departmental Program] | 6 |
| Humanities, Arts, and Social Sciences Requirement | 8 |
| Restricted Electives in Science and Technology (REST) Requirement can be satisfied from among 5.12, 5.60, and 7.03 or 7.05 in the Departmental Program | 2 |
| Laboratory Requirement [can be satisfied by 7.02 in the Departmental Program] | 1 |

| Total GIR Subjects Required for SB Degree | 17 |

**Communication Requirement**

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

| Required Subjects |  
| --- | --- |
| 5.111 or 5.112 Principles of Chemical Science, 12 |  
| or 3.091 Introduction to Solid-State Chemistry, 12 |  
| 5.12 Organic Chemistry 1, 12; REST; Chemistry (GIR) |  
| 20.110J Thermodynamics of Biomolecular Systems, 12; REST; Calculus II (GIR), Chemistry (GIR) |  
| or 20.111 Physical Chemistry of Biomolecular Systems, 12; Calculus II (GIR), Chemistry (GIR), Physics I (GIR); Coreq: Physics II (GIR) |  
| or 5.60 Thermodynamics and Kinetics, 12; REST; Calculus II (GIR), Chemistry (GIR) |  
| 7.012 or 7.013 or 7.014 Introductory Biology, 12 |  
| 7.02 or 10.702 Introduction to Experimental Biology and Communication, 18, LAB, CI-M; Biology (GIR) |  
| or 20.109 Laboratory Fundamentals in Biological Engineering, 15, LAB, CI-M; Biology (GIR), Chemistry (GIR), permission of instructor |  
| 7.03 Genetics, 12; REST; Biology (GIR) |  
| 7.05 General Biochemistry, 12; REST; 5.12, Biology (GIR), or permission of instructor |  
| or 5.07 Biological Chemistry I, 12; 5.12 |  
| 7.06 Cell Biology, 12; 7.03, 7.05 |  
| Restricted Electives | 66 |
| Three undergraduate-level 12-unit subjects offered by the Department of Biology for which 7.03 and/or 7.05 are prerequisites. Exceptions: 7.30J is eligible as a restricted elective; 7.19 cannot be used as a restricted elective. Graduate-level subjects may not be used as restricted electives. Subjects that count as restricted electives are the following: 7.08J, 7.21J, 7.22, 7.23, 7.24, 7.25, 7.26, 7.27, 7.28, 7.29J, 7.30J, 7.31, 7.33, 7.35, 7.36, and 7.37J. |  
| One of the 30-unit project laboratory subjects in the department curriculum. Those currently offered are: 7.13 Experimental Microbial Genetics, 30, CI-M; 7.02, 7.03, 7.05 |  
| 7.16 Experimental Molecular Biology: Biotechnology II, 30, CI-M; 7.02, 7.03, 7.05 |  
| 7.17 Experimental Molecular Biology: Biotechnology III, 30, CI-M; 7.02, 7.03, 7.05 |  
| 7.18 Topics in Experimental Biology, 30, CI-M; 7.02, 7.03, 7.05 |  

| Departmental Program Units That Also Satisfy the GIRs | (66) |

| Unrestricted Electives | 78 |

| Total Units Beyond the GIRs Required for SB Degree | 180 |

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

**Notes**

*Alternate prerequisites are listed in the subject description.

(1) The department recommends 20.110J, 20.111, or 5.60 to fulfill the biology requirements, but will also accept 2.005, 3.012, 8.044, or 10.213 as a substitution.

(2) Either 7.02 or 5.311 satisfies the Institute Laboratory Requirement. However, both or their equivalent are required in order to satisfy medical school entrance requirements.

(3) 7.012/7.013/7.014 are intended to be first biology subjects and are not to be taken after other biology subjects.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
UNDERGRADUATE SUBJECTS

8.01 Physics I
Prereq: None
5-0-7 PHYSICS I
Credit cannot also be received for 8.01, 8.012, 8.011, 8.01T

Introduces classical mechanics. Space and time: straight-line kinematics; motion in a plane; forces and static equilibrium; particle dynamics; with force and conservation of momentum; relative inertial frames and non-inertial force; work, potential energy and conservation of energy; kinetic theory and the ideal gas; rigid bodies and rotational dynamics; vibrational motion; conservation of angular momentum; central force motions; fluid mechanics. Subject taught using the TEAL (Technology-Enabled Active Learning) format which features students working in groups of three, discussing concepts, solving problems, and doing table-top experiments with the aid of computer data acquisition and analysis.
T. Greytak

8.011 Physics I
Prereq: None
U (Spring)
3-2-7 PHYSICS I
Credit cannot also be received for 8.01, 8.012, 8.011, 8.01T

Introduces classical mechanics. Space and time: straight-line kinematics; motion in a plane; forces and equilibrium; experimental basis of Newton's laws; particle dynamics; universal gravitation; collisions and conservation laws; work and potential energy; vibrational motion; conservative forces; inertial forces and non-inertial frames; central force motions; rigid bodies and rotational dynamics. Designed for students with previous experience in 8.01; the subject is designated as 8.01 on the transcript.
Staff

8.012 Physics I
Prereq: None
U (Fall)
5-0-7 PHYSICS I
Credit cannot also be received for 8.01, 8.011, 8.01L, 8.01T

Elementary mechanics, presented in greater depth than in 8.01. Newton's laws, concepts of momentum, energy, angular momentum, rigid body motion, and non-inertial systems. Uses elementary calculus freely; concurrent registration in a math subject more advanced than 18.01 is recommended. In addition to covering the theoretical subject matter, students complete a small experimental project of their own design. Freshmen admitted via AP or Math Diagnostic for Physics Placement results.
M. Zwierlein

8.02 Physics II
Prereq: Physics I (GIR), Calculus I (GIR)
U (Fall, Spring)
3-2-7 PHYSICS II
Credit cannot also be received for 8.02, 8.021

Introduction to electromagnetism and electrostatics: electric charge, Coulomb's law, electric structure of matter; conductors and dielectrics. Concepts of electrostatic field and potential, electrostatic energy. Electric currents, magnetic fields and Ampere's law. Magnetic materials. Time-varying fields and Faraday's law of induction. Basic electric circuits. Electromagnetic waves and Maxwell's equations. Designed for students with previous experience in 8.01; the subject is designated as 8.02 on the transcript. Enrollment limited.
P. Schechter

8.022 Physics II
Prereq: Physics I (GIR), Coreq: Calculus II (GIR)
U (Fall, Spring)
5-0-7 PHYSICS II
Credit cannot also be received for 8.02, 8.021

Parallel to 8.02, but more advanced mathematically. Some knowledge of vector calculus assumed. Maxwell's equations, in both differential and integral form. Electrostatic and magnetic vector potential. Properties of dielectrics and magnetic materials. In addition to the theoretical subject matter, several experiments in electricity and magnetism are performed by the students in the laboratory.
Fall: S. Rappaport
Spring: Staff


8.03 Physics III
Prereq: Calculus II (GIR), Physics II (GIR)
U (Fall, Spring)
5-0-7 REST

Mechanical vibrations and waves; simple harmonic motion, superposition, forced vibrations and resonance, coupled oscillations, and normal modes; vibrations of continuous systems; reflection and refraction; phase and group velocity. Optics; wave solutions to Maxwell’s equations; polarization; Snell’s Law, interference, Huygens’s principle, Fraunhofer diffraction, and gratings.

Fall: P. Jarillo-Herrero
Spring: Staff

8.033 Relativity
Prereq: Physics I (GIR), Calculus II (GIR)
U (Fall)
5-0-7

Normally taken by Physics majors in their sophomore year. Einstein’s postulates; consequences for simultaneity, time dilation, length contraction, and clock synchronization; Lorentz transformation; relativistic effects and paradoxes; Minkowski diagrams; invariants and four-vectors; momentum, energy, and mass; particle collisions. Relativity and electricity; Coulomb’s law; magnetic fields. Brief introduction to Newtonian cosmology. Introduction to some concepts of general relativity; principle of equivalence. The Schwarzschild metric; gravitational red shift; particle and light trajectories; geodesics; Shapiro delay.

T. Figueroa

8.04 Quantum Physics I
Prereq: 8.03 or 6.014; 18.03 or 18.034
U (Fall, Spring)
5-0-7 REST

Experimental basis of quantum physics: photoelectric effect, Compton scattering, photons, Franck-Hertz experiment, the Bohr atom, electron diffraction, de Broglie waves, and wave-particle duality of matter and light. Introduction to wave mechanics: Schroedinger’s equation, wave functions, wave packets, probability amplitudes, stationary states, the Heisenberg uncertainty principle, and zero-point energies. Solutions to Schroedinger’s equation in one dimension: transmission and reflection at a barrier, barrier penetration, potential wells, the simple harmonic oscillator. Schroedinger’s equation in three dimensions: central potentials and introduction to hydrogenic systems.

Fall: P. Jarillo-Herrero
Spring: Staff

8.044 Statistical Physics I
Prereq: 8.03, 18.03
U (Spring)
5-0-7

Introduction to probability, statistical mechanics, and thermodynamics. Random variables, joint and conditional probability densities, and functions of a random variable. Concepts of macroscopic variables and thermodynamic equilibrium, fundamental assumption of statistical mechanics, microcanonical and canonical ensembles. First, second, and third laws of thermodynamics. Numerous examples illustrating a wide variety of physical phenomena such as magnetism, polyatomic gases, thermal radiation, electrons in solids, and noise in electronic devices. Concurrent enrollment in 8.04 is recommended.

K. Rajagopal

8.05 Quantum Physics II
Prereq: 8.04
U (Fall)
5-0-7


J. Negele

8.06 Quantum Physics III
Prereq: 8.05
U (Spring)
5-0-7

Continuation of 8.05. Units: natural units, scales of microscopic phenomena, applications. Time-independent approximation methods: degenerate and nondegenerate perturbation theory, variational method, Born-Oppenheimer approximation, applications to atomic and molecular systems. The structure of one- and two-electron atoms: overview, spin-orbit and relativistic corrections, fine structure, variational approximation, screening, Zeeman and Stark effects. Charged particles in a magnetic field: Landau levels and integer quantum hall effect. Scattering: general principles, partial waves, review of one-dimension, low-energy approximations, resonance, Born approximation. Time-dependent perturbation theory. Students research and write a paper on a topic related to the content of 8.05 and 8.06.

Staff

8.07 Electromagnetism II
Prereq: 8.03, 18.03
U (Fall)
4-0-8


J. Belcher

8.08 Statistical Physics II
Prereq: 8.044, 8.05
U (Spring)
4-0-8


Staff

8.09 Classical Mechanics III
Prereq: Physics I (GIR)
U (Fall)
4-0-8

Formal introduction to classical mechanics, Euler-Lagrange equations, Hamilton’s equations of motion used to describe central force motion, scattering, perturbation theory and Noether’s theorem. Extension to continuous and relativistic systems and classical electrodynamics.

B. Surrow
8.13 Experimental Physics I
Prereq: 8.04
0-6-12 Institute LAB
8.14 Experimental Physics II
Prereq: 8.05, 8.13
0-6-12 Institute LAB

Four fundamental laboratory experiments are carried out each term, covering most aspects of modern physics relating to names such as Rutherford, Franck-Hertz, Hall, Ramsauer, Doppler, Fraunhofer, Faraday, Mossbauer, Compton, and Stern-Gerlach. Stresses basic experimental techniques and data analysis, and written and oral presentation of experiment results. 8.14 requires knowledge of quantum mechanics at the 8.05 level.
D. Litster

8.18 Special Problems in Undergraduate Physics
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

Opportunity for undergraduates to engage in experimental or theoretical research under the supervision of a staff member. Specific approval required in each case.
Consult D. E. Pritchard

8.19 Readings in Physics
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

Supervised reading and library work. Choice of material and allotment of time according to individual needs. For students who want to do work not provided for in the regular subjects. Specific approval required in each case.
Consult D. E. Pritchard

8.20 Introduction to Special Relativity
Prereq: Physics I (GIR), Calculus I (GIR)
U (IAP)
2-0-7 REST

Introduces the basic ideas and equations of Einstein’s special theory of relativity. Topics include Lorentz transformations, length contraction and time dilation, four vectors, Lorentz invariants, relativistic energy and momentum, relativistic kinematics, Doppler shift, space-time diagrams, relativity paradoxes, and some concepts of general relativity. Intended for freshmen and sophomores. Not usable as a restricted elective by Physics majors. Credit cannot be received for 8.20 if credit for 8.033 is or has been received in the same or prior terms.
S. Kowalski

8.21 Physics of Energy
Prereq: Physics II (GIR), Calculus II (GIR), Chemistry (GIR)
U (Fall)
5-0-7 REST

A comprehensive introduction to the fundamental physics of energy systems that emphasizes quantitative analysis. Focuses on the fundamental physical principles underlying energy processes and on the application of these principles to practical calculations. Applies mechanics and electromagnetism to energy systems; introduces and applies basic ideas from thermodynamics, quantum mechanics, and nuclear physics. Examines energy sources, conversion, transport, losses, storage, conservation, and end uses. Analyzes the physics of side effects, such as global warming and radiation hazards. Provides students with technical tools and perspective to evaluate energy choices quantitatively at both national policy and personal levels.
R. L. Jaffe, W. Taylor

8.22 Interactive Introduction to Nuclear Magnetic Resonance
(Same subject as 22.920J)
Prereq: Calculus II (GIR)
G (IAP)
1-2-0 H-LEVEL Grad Credit

See description under subject 22.920J.
D. G. Cory, S. D. Sewell

8.223 Classical Mechanics II
Prereq: Physics I (GIR), Calculus II (GIR)
U (IAP)
2-0-4

A broad, theoretical treatment of classical mechanics, useful in its own right for treating complex dynamical problems, but essential to understanding the foundations of quantum mechanics and statistical physics. Generalized coordinates, Lagrangian and Hamiltonian formulations, canonical transformations, and Poisson brackets. Applications to continuous media. The relativistic Lagrangian and Maxwell’s equations. P. Fisher

8.224 Exploring Black Holes: General Relativity and Astrophysics
Prereq: 8.033 or 8.20
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9

Study of physical effects in the vicinity of a black hole as a basis for understanding general relativity, astrophysics, and elements of cosmology. Extension to current developments in theory and observation. Energy and momentum in flat space-time; the metric; curvature of space-time near rotating and nonrotating centers of attraction; trajectories and orbits of particles and light; elementary models of the Cosmos. Weekly meetings include an evening seminar and recitation. The last third of the term is reserved for collaborative research projects on topics such as the Global Positioning System, solar system tests of relativity, descending into a black hole, gravitational lensing, gravitational waves, Gravity Probe B, and more advanced models of the cosmos. Subject has online components that are open to selected MIT alumni. Alumni wishing to participate should contact Professor Bertschinger at edbert@mit.edu. Enrollment limited to 40.
E. Bertschinger
8.231 Physics of Solids I
Prereq: 8.044, Coreq: 8.05
U (Fall)
4-0-8
Introduction to the basic concepts of the quantum theory of solids. Topics: periodic structure and symmetry of crystals; diffraction; reciprocal lattice; chemical bonding; lattice dynamics, phonons, thermal properties; free electron gas; model of metals; Bloch theorem and band structure, nearly free electron approximation; tight binding method; Fermi surface; semiconductors, electrons, holes, impurities; optical properties, excitons; and magnetism.
X. G. Wen

8.251 String Theory for Undergraduates
Prereq: 8.033, 8.044, 8.05
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
4-0-8
Introduction to the main concepts of string theory, i.e. quantum mechanics of a relativistic string. Develops aspects of string theory and makes it accessible to students familiar with basic electromagnetism and statistical mechanics, including the study of D-branes and string thermodynamics.
B. Zwiebach

8.261J Introduction to Computational Neuroscience
(Same subject as 9.29J)
Prereq: 18.03, Physics II (GIR); or permission of instructor
U (Fall)
3-0-9
See description under subject 9.29J.
M. Fee

8.276 Nuclear and Particle Physics
Prereq: 8.05
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
4-0-8
A modern view of the fundamental structure of matter. Starting from a model that views quarks as basic building blocks of mesons and baryons, the properties and interactions of these particles are established. Quantum numbers and multiplet structure of particle families. Nuclei as multibaryon systems: stability, radioactive decay, and reactions. Current topics in nuclear and particle physics research at MIT.
J. Conrad

8.277J Introduction to Particle Accelerators
(Same subject as 6.608J)
Prereq: 6.013 or 8.07
U (Spring)
3-0-9
Principles of acceleration: beam properties; linear accelerators, synchrotrons, and storage rings. Accelerator technologies: radio frequency cavities, bending and focusing magnets, beam diagnostics. Particle beam optics and dynamics. Special topics: measures of accelerators performance in science, medicine and industry; synchrotron radiation sources; free electron lasers; high-energy colliders; and accelerators for radiation therapy.
W. Barletta

8.282J Introduction to Astronomy
(Same subject as 12.402J)
Prereq: Physics I (GIR)
U (Spring)
3-0-6 REST
Quantitative introduction to physics of the solar system, stars, interstellar medium, the galaxy, and universe, as determined from a variety of astronomical observations and models. Topics: planets, planet formation; stars, the Sun, “normal” stars, star formation; stellar evolution, supernovae, compact objects (white dwarfs, neutron stars, and black holes), pulsars, binary x-ray sources; star clusters, globular and open clusters; interstellar medium, gas, dust, magnetic fields, cosmic rays; distance ladder; galaxies, normal and active galaxies, jets; gravitational lensing; large scale structure; Newtonian cosmology, dynamical expansion and thermal history of the universe; cosmic microwave background radiation; big bang nucleosynthesis. No prior knowledge of astronomy necessary. Not usable as a restricted elective by Physics majors.
Staff

8.284 Modern Astrophysics
Prereq: 8.04, Coreq: 8.05
U (Spring)
3-0-9
Applications of physics (Newtonian, statistical, and quantum mechanics) to fundamental processes that occur in celestial objects. Includes main-sequence stars, collapsed stars (white dwarfs, neutron stars, and black holes), pulsars, supernovae, the interstellar medium, galaxies, and as time permits, active galaxies, quasars, and cosmology. Observational data discussed. No prior knowledge of astronomy is required.
Staff

8.286 The Early Universe
Prereq: 18.03, Physics II (GIR)
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 REST
Introduction to modern cosmology. First half deals with the development of the big bang theory from 1915 to 1980, and latter half with recent impact of particle theory. Topics: special relativity and the Doppler effect, Newtonian cosmological models, introduction to non-Euclidean spaces, thermal radiation and early history of the universe, big bang nucleosynthesis, introduction to grand unified theories and other recent developments in particle theory, baryogenesis, the inflationary universe model, and the evolution of galactic structure.
A. Guth

8.287J Observational Techniques of Optical Astronomy
(Same subject as 12.410J)
Prereq: 8.282J, 12.402J, 12.409, or other introductory astronomy course; Coreq: 8.03
U (Fall)
3-4-8 Institute LAB
See description under subject 12.410J.
J. L. Elliot

8.292J Fluid Physics
(Same subject as 12.330J)
Prereq: 8.044, 5.60, or permission of instructor
U (Spring)
3-0-9
A physics-based introduction to the properties of fluids and fluid systems, with examples drawn from a broad range of sciences, including astrophysical and theoretical physics. Definitions of fluids and the notion of continuum. Equations of state and continuity, hydrostatics and conservation of momentum; ideal fluids and Euler’s equation; viscosity and the Navier-Stokes equation. Energy considerations, fluid thermodynamics, and isentropic flow. Compressible versus incompressible and rotational versus irrotational flow; Bernoulli’s theorem; steady flow, streamlines and potential flow. Circulation and vorticity. Kelvin’s theorem. Boundary layers. Fluid waves and instabilities. Quantum fluids.
P. Joss
8.298 Selected Topics in Physics
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Presentation of topics of current interest, with content varying from year to year.
Consult T. Greytak

8.299 Physics Teaching
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
For qualified undergraduate students interested in gaining some experience in teaching. Laboratory, tutorial, or classroom teaching under the supervision of a faculty member. Students selected by interview.
Consult D. E. Pritchard

8.UR Undergraduate Research
Prereq: None
U (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Research opportunities in physics. For further information, contact the departmental UROP coordinator.
D. E. Pritchard

8.ThU Undergraduate Physics Thesis
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Program of research leading to the writing of an SB thesis; to be arranged by the student under approved supervision.
Information: D. E. Pritchard

GRADUATE SUBJECTS

8.311 Electromagnetic Theory I
Prereq: 8.07
G (Spring)
4-0-8 H-LEVEL Grad Credit
Basic principles of electromagnetism: experimental basis, electrostatics, magnetic fields of steady currents, motional emf and electromagnetic induction, Maxwell’s equations, propagation and radiation of electromagnetic waves, electric and magnetic properties of matter, and conservation laws. Subject uses appropriate mathematics but emphasizes physical phenomena and principles.
Staff

8.321 Quantum Theory I
Prereq: 8.05, 8.21
G (Fall)
4-0-8 H-LEVEL Grad Credit
8.322 Quantum Theory II
Prereq: 8.07, 8.321
G (Spring)
4-0-8 H-LEVEL Grad Credit
R. Jackiw

8.323 Relativistic Quantum Field Theory I
Prereq: 8.321
G (Spring)
4-0-8 H-LEVEL Grad Credit
Staff

8.324 Relativistic Quantum Field Theory II
Prereq: 8.322, 8.323
G (Fall)
4-0-8 H-LEVEL Grad Credit
The second term of the quantum field theory sequence. Develops in depth some of the topics discussed in 8.323 and introduces some advanced material. Topics: perturbation theory and Feynman diagrams, scattering theory, Quantum Electrodynamics, one loop renormalization, quantization of non-abelian gauge theories, the Standard Model of particle physics, other topics.
H. Liu

8.325 Relativistic Quantum Field Theory III
Prereq: 8.324
G (Spring)
4-0-8 H-LEVEL Grad Credit
The third and last term of the quantum field theory sequence. Its aim is the proper theoretical discussion of the physics of the standard model. Topics: quantum chromodynamics, Higgs phenomenon and a description of the standard model; deep-inelastic scattering and structure functions; basics of lattice gauge theory; operator products and effective theories; detailed structure of the standard model; spontaneously broken gauge theory and its quantization; instantons and theta-vacua; topological defects; introduction to supersymmetry.
Staff

8.333 Statistical Mechanics I
Prereq: 8.044, 8.05
G (Fall)
4-0-8 H-LEVEL Grad Credit
8.334 Statistical Mechanics II
Prereq: 8.333
G (Spring)
4-0-8 H-LEVEL Grad Credit
8.333: M. Kardar
8.334: Staff

8.351 Classical Mechanics: A Computational Approach
(Same subject as 6.946J, 12.620I)
(Subject meets with 12.008)
Prereq: Physics I (GIR), 18.03, permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit
See description under subject 12.620J.
J. Wisdom, G. J. Sussman
8.361 Quantum Theory of Many-Particle Systems
Prereq: 8.322, 8.333
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Introduces general many-body theory applicable to low temperature, nuclear, and solid-state physics. Reviews occupation number representation and classical Mayer expansion. Perturbation theory: diagrammatic expansions and linked-cluster theorem for zero or finite temperature systems of fermions or bosons. Green’s functions: analytic properties, equations of motion, relation to observables, approximations, linear response theory, and random phase approximation. Superconductivity: electron-phonon interaction, instability of normal state, BCS ground state, perturbation theory.
T. W. Donnelly

8.371j Quantum Information Science
(Same subject as 6.443J, 18.436J)
Prereq: 18.435
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 18.436J.
P. Shor

8.381, 8.382 Selected Topics in Theoretical Physics
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit

Topics of current interest in theoretical physics, varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
Consult P. A. Lee

8.391 Special Problems in Graduate Physics
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

8.392 Special Problems in Graduate Physics
Prereq: Permission of instructor
G (Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Advanced problems in any area of experimental or theoretical physics, with assigned reading and consultations.
Consult R. Ashoori

8.395j Teaching College-Level Science and Engineering
(Same subject as 5.95j, 6.982j, 7.59j, 18.094j)
Prereq: None
G (Spring)
2-0-2 [P/D/F]
See description under subject 5.95j.
L. Breslow

8.398 Selected Topics in Graduate Physics
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Presentation of topics of current interest with content varying from year to year.
Consult T. Greytak

8.399 Physics Teaching
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

For qualified graduate students interested in gaining some experience in teaching. Laboratory, tutorial, or classroom teaching under the supervision of a faculty member. Students selected by interview.
Consult S. P. Robinson

Physics of Atoms, Radiation, Solids, Fluids, and Plasmas

8.421 Atomic and Optical Physics I
Prereq: 8.05
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

The first of a two-term subject sequence that provides the foundations for contemporary research in selected areas of atomic and optical physics. The interaction of radiation with atoms: resonance; absorption, stimulated and spontaneous emission; methods of resonance, dressed atom formalism, masers and lasers, cavity quantum electrodynamics; structure of simple atoms, behavior in very strong fields; fundamental tests: time reversal, parity violations, Bell’s inequalities; and experimental methods.
Staff

8.422 Atomic and Optical Physics II
Prereq: 8.05
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

The second of a two-term subject sequence that provides the foundations for contemporary research in selected areas of atomic and optical physics. Non-classical states of light- squeezed states; multi-photon processes, Raman scattering; coherence- level crossings, quantum beats, double resonance, superradiance; trapping and cooling- light forces, laser cooling, atom optics, spectroscopy of trapped atoms and ions; atomic interactions- classical collisions, quantum scattering theory, ultracold collisions; and experimental methods.
Staff

8.431j Nonlinear Optics
(Same subject as 6.634J)
Prereq: 6.013 or 8.07
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.634J.
E. P. Ippen, J. G. Fujimoto

8.481, 8.482 Selected Topics in Physics of Atoms and Radiation
Prereq: 8.321
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit

Presentation of topics of current interest, with content varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
Consult P. A. Lee

8.511 Theory of Solids I
Prereq: 8.231
G (Fall)
3-0-9 H-LEVEL Grad Credit

P. A. Lee
8.512 Theory of Solids II
Prereq: 8.511
G (Spring)
3-0-9 H-LEVEL Grad Credit


Staff

8.513 Many-Body Theory for Condensed Matter Systems
Prereq: 8.05, 8.08, 8.033, 8.231J
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Concepts and physical pictures behind various phenomena that appear in interacting many-body systems. Visualization occurs through concentration on path integral, mean-field theories and semiclassical picture of fluctuations around mean-field state. Topics covered: interacting boson/fermion systems, Fermi liquid theory and bosonization, symmetry breaking and nonlinear sigma-model, quantum gauge theory, quantum Hall theory, mean-field theory of spin liquids and quantum order, string-net condensation and emergence of light and fermions.

L. Levitov

8.514 Strongly Correlated Systems in Condensed Matter Physics
Prereq: 8.322, 8.333
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Study of condensed matter systems where interactions between electrons play an important role. Topics vary depending on lecturer but may include low-dimension magnetic and electronic systems, disorder and quantum transport, magnetic impurities (the Kondo problem), quantum spin systems, the Hubbard model and high-temperature superconductors. Topics are chosen to illustrate the application of diagrammatic techniques, field-theory approaches, and renormalization group methods in condensed matter physics.

S. Todadri

8.575J Statistical Thermodynamics of Complex Liquids
(Same subject as 10.44J, 22.52J)
Prereq: 8.08, 10.213
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit

See description under subject 10.44J.

D. Blankschein, S. H. Chen

8.581, 8.582 Selected Topics in Condensed Matter Physics
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9
Can be repeated for credit

Presentation of topics of current interest, with contents varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.

Consult P. A. Lee

8.591J Systems Biology
(Same subject as 7.81J)
(Subject meets with 7.32)
Prereq: None
G (Fall)
3-0-9

Topics include molecular, cellular, and developmental systems biology. Molecular systems component covers constructing and modeling of genetic networks, control theory and genetic networks, lambda phage as a genetic switch, synthetic genetic switches, bacterial chemotaxis, genetic oscillators, and circadian rhythms. Cellular systems includes reaction diffusion equations, local activation and global inhibition models, gradient sensing systems, and center-finding networks. Developmental systems covers general pattern formation models, modeling cell-cell communication, quorum sensing, and models for Drosophila development. Students taking the graduate version explore the subject in more depth.

A. Van Oudenaarden

8.592J Statistical Physics in Biology
(Same subject as HST.452J)
Prereq: 8.333 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit


M. Kardar, L. Mirny

8.593J Biological Physics
(Same subject as HST.450J)
Prereq: 8.044 recommended but not necessary
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
4-0-8 H-LEVEL Grad Credit

Designed to provide seniors and first-year graduate students with a quantitative, analytical understanding of selected biological phenomena. Topics include experimental and theoretical basis for the phase boundaries and equation of state of concentrated protein solutions, with application to diseases such as sickle cell anemia and cataract. Protein-ligand binding and linkage and the theory of allosteric regulation of protein function, with application to proteins as stores as transporters in respiration, enzymes in metabolic pathways, membrane receptors, regulators of gene expression, and self-assembling scaffolds. The physics of locomotion and chemoreception in bacteria and the biophysics of vision, including the theory of transparency of the eye, molecular basis of photo reception, and the detection of light as a signal-to-noise discrimination.

G. Benedek

8.594J Introduction to Neural Networks
(Same subject as 9.641J)
Prereq: 9.29 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 9.641J.

H. S. Seung

8.613J Introduction to Plasma Physics I
(Same subject as 6.651J, 22.611J)
Prereq: 6.013, 8.07, or 22.105; 18.04 or Coreq: 18.075
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 22.611J.

J. Egedal-Pedersen
8.614 Introduction to Plasma Physics II
(Same subject as 6.652), 22.612)
Prereq: 6.651J, 8.613J, or 22.611J
G (Spring)
3-0-9 H-LEVEL Grad Credit
Linear waves and instabilities in magnetized plasma; solutions of Vlasov-Maxwell equations in homogeneous and inhomogeneous plasmas; conservation principles for energy and momentum; quasi-linear theory and nonlinear stabilization; solitons and coherent nonlinear phenomena; collisions and discrete particle effects; fluctuations in a stable plasma; Fokker-Planck equation and transport phenomena. A subject description tailored to fit the background and interests of the attending students distributed shortly before and at the beginning of the subject.
Staff

8.624 Plasma Waves
Prereq: 8.613J
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Comprehensive theory of electromagnetic waves in a magnetized plasma. Wave propagation in cold and hot plasmas. Energy flow. Absorption by Landau and cyclotron damping and by transit time magnetic pumping (TTMP). Wave propagation in inhomogeneous plasma: accessibility, WKB theory, mode conversion, connection formulae, and Budden tunneling. Applications to RF plasma heating, wave propagation in the ionosphere and laser-plasma interactions. Wave propagation in toroidal plasmas, and applications to ion cyclotron (ICRF), electron cyclotron (ECRH), and lower hybrid (LH) wave heating. Quasi-linear theory and applications to RF current drive in tokamaks. Extensive discussion of relevant experimental observations.
Staff

8.641 Physics of High-Energy Plasmas I
Prereq: 8.613J
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
8.642 Physics of High-Energy Plasmas II
Prereq: 8.613J
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Basic concepts of plasmas, with temperatures of thermonuclear interest, relevant to fusion research and astrophysics. Microscopic transport processes due to interparticle collisions and collective modes (e.g., microinstabilities). Relevant macroscopic transport coefficients (electrical resistivity, thermal conductivities, particle “diffusion”). Runaway and slide-away regimes. Magnetic reconnection processes and their relevance to experimental observations. Radiation emission from inhomogeneous plasmas. Conditions for thermonuclear burning and ignition (D-T and “advanced” fusion reactions, plasmas with polarized nuclei). Role of “impurity” nuclei. “Finite-β” (pressure) regimes and ballooning modes. Convective modes in configuration and velocity space. Trapped particle regimes. Nonlinear and explosive instabilities. Interaction of positive and negative energy modes. Each subject can be taken independently.
Staff

8.681, 8.682 Selected Topics in Fluid and Plasma Physics
Prereq: 8.613J
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Presentation of topics of current interest, with content varying from year to year. Subject not routinely offered; given when interest is indicated.
Consult M. Porkolab

Nuclear and Particle Physics

8.701 Introduction to Nuclear and Particle Physics
Prereq: 8.321, Coreq: 8.322
G (Fall)
3-0-9 H-LEVEL Grad Credit
The phenomenology and experimental foundations of particle and nuclear physics; the fundamental forces and particles, composites. Interactions of particles with matter, and detectors. SU(2), SU(3), models of mesons and baryons. QED, weak interactions, parity violation, lepton-nucleon scattering, and structure functions. QCD, gluon field and color, W and Z fields, electro-weak unification, the CKM matrix. Nucleon-nucleon interactions, properties of nuclei, single- and collective-particle models. Electron and hadron interactions with nuclei. Relativistic heavy ion collisions, and transition to quark-gluon plasma.
T. W. Donnelly

8.711 Nuclear Physics
Prereq: 8.322, 8.701
G (Spring)
4-0-8 H-LEVEL Grad Credit
J. Matthews

8.712 Advanced Topics in Nuclear Physics
Prereq: 8.711 or permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Subject for experimentalists and theorists with rotation of the following topics: (1) Nuclear chromodynamics—introduction to QCD, structure of nucleons, lattice QCD, phases of hadronic matter; and relativistic heavy ion collisions. (2) Medium-energy physics—nuclear and nucleon structure and dynamics studied with medium- and high-energy probes (neutrinos, photons, electrons, nucleons, pions, and kaons). Studies of weak and strong interactions.
Consult P. Fisher

8.781, 8.782 Selected Topics in Nuclear Theory
Prereq: 8.323
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Presents topics of current interest in nuclear structure and reaction theory, with content varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
Consult E. Farhi

8.811 Particle Physics
Prereq: 8.701
G (Fall)
3-0-9 H-LEVEL Grad Credit
U. Becker
8.821 String Theory
Prereq: 8.324
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
An introduction to string theory. Basics of conformal field theory; light-cone and covariant quantization of the relativistic bosonic string; quantization and spectrum of supersymmetric 10-dimensional string theories; T-duality and D-branes; toroidal compactification and orbifolds; 11-dimensional supergravity and M-theory.
J. McGreevy

8.831I Supersymmetric Quantum Field Theories
(Same subject as 18.396I)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 18.396I.
D. Z. Freedman

8.841 Electroweak Interactions
Prereq: 8.324
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
An introduction to the standard model of electroweak interactions and beyond; neutrino interactions and masses; the CKM matrix; lepton scattering off of nucleons and nuclei; the search for the Higgs boson; supersymmetric extension of the standard model. Topics vary with instructor.
Staff

8.851 Strong Interactions
Prereq: 8.324
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
The strong force which bind quarks together is described by a relativistic quantum field theory called quantum chromodynamics (QCD). Subject surveys: The QCD Langrangian, asymptotic freedom and deep inelastic scattering, jets, the QCD vacuum, instantons and the U(1) problem, lattice and deep inelastic scattering, jets, the QCD surveys: The QCD Langrangian, asymptotic freedom, and other phases of QCD.
I. Stewart

8.861 Advanced Topics in Superfluidity
Prereq: 8.324
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Basic pairing theory, effective field theory and spontaneous symmetry breaking; well-established applications to liquid helium 3 as a warm-up; research will be explored including anisotropic superconductivity in heavy fermion systems and cuprates; color superconductivity in high-density QCD; and pairing in fermion systems with mismatched Fermi surfaces, including ultracold atom systems. Additional ideas needed to discuss the fractional quantum Hall effect will be reviewed, emphasizing its connection to conventional superfluidity, and pointing toward aspects of anyon behavior potentially relevant for quantum information processing.
F. Wilczek

8.871, 8.872 Selected Topics in Theoretical Particle Physics
Prereq: 8.323
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Presents topics of current interest in theoretical particle physics, with content varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
Consult E. Farhi

8.881, 8.882 Selected Topics in Experimental Particle Physics
Prereq: 8.811
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Presents topics of current interest in experimental particle physics, with content varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
Consult P. Fisher

Space Physics and Astrophysics

8.901 Astrophysics I
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Staff

8.902 Astrophysics II
Prereq: 8.901
G (Fall)
3-0-9 H-LEVEL Grad Credit
M. Tegmark

8.913 Plasma Astrophysics I
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
8.914 Plasma Astrophysics II
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
For students interested in space physics, astrophysics, and plasma physics in general. Magnetospheres of rotating magnetized planets, ordinary stars, neutron stars, and black holes. Pulsar models: processes for slowing down, particle acceleration, and radiation emission; accreting plasmas and x-ray stars; stellar winds; heliosphere and solar wind-relevant magnetic field configuration, measured particle distribution in velocity space and induced collective modes; stability of the current sheet and collisionless processes for magnetic reconnection; theory of collisionless shocks; solitons; Fermi-Oseen-Rosenbluth sheet; solar flare models; heating processes of the solar corona; earth’s magnetosphere (auroral phenomena and their interpretation, bowshock, magnetotail, trapped particle effects); relationship between gravitational (galactic) plasmas and electromagnetic plasmas. 8.913 deals with heliospheric, 8.914 with extra-heliospheric plasmas.
B. Coppi
8.921 Stellar Structure and Evolution
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Observable stellar characteristics; overview of observational information. Principles underlying calculations of stellar structure. Physical processes in stellar interiors; properties of matter and radiation; radiative, conductive, and convective heat transport; nuclear energy generation; nucleosynthesis; and neutrino emission. Protostars; the main sequence, and the solar neutrino flux; advanced evolutionary stages; variable stars; planetary nebulae, supernovae, white dwarfs, and neutron stars; close binary systems; and abundance of chemical elements.

Staff

8.942 Cosmology
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Thermal backgrounds in space. Cosmological principle and its consequences: Newtonian cosmology and types of “universes”; survey of relativistic cosmology; horizons. Overview of evolution in cosmology; radiation and element synthesis; physical models of the “early stages.” Formation of large-scale structure to variability of physical laws. First and last states. Some knowledge of relativity expected. 8.962 recommended though not required.

M. Tegmark

8.952 Particle Physics of the Early Universe
Prereq: 8.323, Coreq: 8.324
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Basics of general relativity, standard big bang cosmology, thermodynamics of the early universe, cosmic background radiation, primordial nucleosynthesis, basics of the standard model of particle physics, electroweak and QCD phase transition, basics of group theory, grand unified theories, baryon asymmetry, monopoles, cosmic strings, domain walls, axions, inflationary universe, and structure formation.

A. Guth

8.962 General Relativity
Prereq: 18.03, 18.06, 8.07
G (Spring)
4-0-8 H-LEVEL Grad Credit
The basic principles of Einstein’s general theory of relativity, differential geometry, experimental tests of general relativity, black holes, and cosmology.

Staff

8.971, 8.972 Astrophysics Seminar
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Advanced seminar on current topics, with a different focus each term. Typical topics: gravitational lenses, active galactic nuclei, neutron stars and pulsars, galaxy formation, supernovae and supernova remnants, brown dwarfs, and extrasolar planetary systems. The presenter at each session is selected by drawing names from a hat containing those of all attendees. Offered if sufficient interest is indicated.

Consult D. Chakrabarty

8.981, 8.982 Selected Topics in Astrophysics
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Topics of current interest, varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.

Consult D. Chakrabarty

8.964 Graduate Physics Thesis
Prereq: None-
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research leading to the writing of an SM, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member.

Consult R. Ashoori
# Bachelor of Science in Physics/Course 8

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
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<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
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<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
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<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

## Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

## PLUS Departmental Program

<table>
<thead>
<tr>
<th>Subject names below are followed by credit units, and by prerequisites, if any (corequisites are indicated in italics).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Subjects</td>
</tr>
<tr>
<td>8.03 Physics II, 12; REST; Physics II (GIR), Calculus II (GIR)</td>
</tr>
<tr>
<td>18.03 Differential Equations, 12, REST; Calculus II (GIR) or</td>
</tr>
<tr>
<td>18.034 Differential Equations, 12, REST; Calculus II (GIR)</td>
</tr>
<tr>
<td>8.04 Quantum Physics I, 12; REST; 8.03*, 18.03*</td>
</tr>
<tr>
<td>8.044 Statistical Physics I, 12; 8.03, 18.03</td>
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<tr>
<td>Physics: Flexible Option</td>
</tr>
<tr>
<td>One of the following subjects:</td>
</tr>
<tr>
<td>8.21 Physics of Energy, 12; Physics II (GIR), Calculus II (GIR), Chemistry (GIR)</td>
</tr>
<tr>
<td>8.223 Classical Mechanics II, 6; Physics I (GIR), Calculus II (GIR)</td>
</tr>
<tr>
<td>One of the following subjects:</td>
</tr>
<tr>
<td>8.05 Quantum Physics II, 12; 8.04</td>
</tr>
<tr>
<td>8.20 Introduction to Special Relativity, 9, REST; Physics I (GIR), Calculus I (GIR)</td>
</tr>
<tr>
<td>8.033 Relativity, 12; Physics I (GIR), Calculus II (GIR)</td>
</tr>
<tr>
<td>One of the following experimental experiences:</td>
</tr>
<tr>
<td>8.13 Experimental Physics I, 18, LAB, CI-M; 8.04</td>
</tr>
<tr>
<td>A laboratory subject of similar intensity in another department</td>
</tr>
<tr>
<td>An experimentally oriented summer externship</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Physics: Focused Option</td>
</tr>
<tr>
<td>8.033 Relativity, 12; Physics I (GIR), Calculus II (GIR)</td>
</tr>
<tr>
<td>8.05 Quantum Physics II, 12; 8.04</td>
</tr>
<tr>
<td>8.06 Quantum Physics III, 12, CI-M; 8.05</td>
</tr>
<tr>
<td>8.13 Experimental Physics I, 18, LAB, CI-M; 8.04</td>
</tr>
<tr>
<td>8.14 Experimental Physics II, 18, LAB; 8.05</td>
</tr>
<tr>
<td>8.223 Classical Mechanics II, 6; Physics I (GIR), Calculus II (GIR)</td>
</tr>
<tr>
<td>8.7HU Thesis (12 units)(1)</td>
</tr>
</tbody>
</table>

## Restricted Electives

<table>
<thead>
<tr>
<th>Subject names below are followed by credit units, and by prerequisites, if any (corequisites are indicated in italics).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical: Flexible Option</td>
</tr>
<tr>
<td>At least one subject in the Department of Physics in addition to those listed above (12 units)(2)</td>
</tr>
<tr>
<td>Three subjects forming one intellectually coherent unit in some area, not necessarily physics, subject to the approval of the department (36 units)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Physics: Focused Option</td>
</tr>
<tr>
<td>One subject in the Department of Mathematics beyond 18.03 (12 units)</td>
</tr>
<tr>
<td>Two subjects in the Department of Physics in addition to those listed above,(3) including at least one of the following: 8.07, 8.08, and 8.09 (24 units)</td>
</tr>
</tbody>
</table>

## Departmental Program Units That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Subject names below are followed by credit units, and by prerequisites, if any (corequisites are indicated in italics).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Departmental Program Units That Also Satisfy the GIRs</td>
</tr>
<tr>
<td>(24–36)</td>
</tr>
<tr>
<td>Unrestricted Electives</td>
</tr>
<tr>
<td>(48–87)</td>
</tr>
</tbody>
</table>

## Total Units Beyond the GIRs Required for SB Degree

<table>
<thead>
<tr>
<th>Subject names below are followed by credit units, and by prerequisites, if any (corequisites are indicated in italics).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
</tr>
<tr>
<td>180–186</td>
</tr>
</tbody>
</table>

No subject can be counted both as part of the 17-subject GIRs and as part of the 180–186 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

## Notes

*Alternate prerequisites and corequisites are listed in the subject description.

(1) A thesis of 12 units is required. Not more than 30 units of thesis credit may be included in the minimum of 180 units beyond the General Institute Requirements required for the SB degree.

(2) Subject descriptions identify subjects that cannot be used for this purpose.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
9.00 Introduction to Psychology
Prereq: None
U (Spring)
4-0-8 HASS
Credit cannot also be received for SP.318
A survey of the scientific study of human nature, including how the mind works, and how the brain supports the mind. Topics include the mental and neural bases of perception, emotion, learning, memory, cognition, child development, personality, psychopathology, and social interaction. Consideration of how such knowledge relates to debates about nature and nurture, free will, consciousness, human differences, self and society. Enrollment limited to 300.
J. D. Gabrieli

9.01 Introduction to Neuroscience
Prereq: Physics II (GIR) or permission of instructor
U (Fall)
4-0-8 REST
Introduction to the mammalian nervous system, with emphasis on the structure and function of the human brain. Topics include the function of nerve cells, sensory systems, control of movement, learning and memory, and diseases of the brain.
H. S. Seung, M. Bear

9.011 Systems Neuroscience
Prereq: Permission of instructor; admission to BCS graduate program
G (Fall)
6-0-12 H-LEVEL Grad Credit
Survey of principles underlying the structure and function of the nervous system, with a focus on systems approaches. Topics: development of the nervous system and its connections, sensory systems of the brain, the motor system, higher cortical functions, behavioral and cellular analyses of learning and memory. A survey of brain and behavioral studies for first-year graduate students.
E. K. Miller, M. Wilson

9.012 Cognitive Science
Prereq: Permission of instructor
G (Spring)
6-0-12 H-LEVEL Grad Credit
Intensive survey of cognitive science. Topics include visual perception, language, memory, cognitive architecture, learning, reasoning, decision-making, and cognitive development. Topics covered from behavioral, computational, and neural perspectives.
E. Gibson, P. Sinha, J. Tenenbaum

9.013J Cellular and Molecular Neurobiology
(Same subject as 7.68J)
Prereq: 9.011 or permission of instructor
G (Spring)
6-0-12 H-LEVEL Grad Credit
Major areas of cellular and molecular neurobiology including excitable cells and membranes, ion channels and receptors, synaptic transmission, cell-type determination, neurogenesis, axon guidance, neuronal cell biology, neurotrophin signaling and cell survival, synapse formation and neural plasticity. Includes lectures and exams, and involves presentation and discussion of primary literature. Focuses on major concepts and recent advances in experimental neuroscience.
M. Constantine-Paton, L.-H. Tsai, W. Quinn

9.02 Systems Neuroscience Laboratory
Prereq: 9.01
U (Spring)
2-4-6 Institute LAB
Consists of a series of laboratories designed to give students experience with basic techniques for conducting systems neuroscience research. Includes sessions on anatomical, neurophysiological, and data acquisition and analysis techniques, and ways these techniques are used to study nervous system function. Training provided in the art of scientific writing with feedback designed to improve writing skills. Assignments include weekly preparation for lab sessions, two major lab reports and a series of basic computer programming tutorials (MATLAB). Involves the use of experimental animals. Enrollment limited.
J. J. DiCarlo, C. I. Moore

9.03 Neural Basis of Learning and Memory
Prereq: 9.01
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9
Highlights the interplay between cellular and molecular storage mechanisms and the cognitive neuroscience of memory. Emphasis on human and animal models of hippocampal mechanisms and function. Lectures and discussion of papers.
M. Wilson, S. Corkin

9.036 The Visual System
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-6 H-LEVEL Grad Credit
The organization of the mammalian visual system and the manner in which shape, color, texture, motion, and depth are processed.
P. H. Schiller

9.04 Neural Basis of Vision and Audition
Prereq: 9.01 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9
Examines the neural bases of visual and auditory processing for perception and sensorimotor control. Focuses on physiological and anatomical studies of the mammalian nervous system as well as behavioral studies of animals and humans. Studies visual pattern, color and depth perception, auditory responses and speech coding, and spatial localization.
P. H. Schiller, M. C. Brown

9.044J Brain Mechanisms for Hearing and Speech
(Same subject as HST.722J)
Prereq: HST.723 or permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
4-0-8 H-LEVEL Grad Credit
See description under subject HST.722J.
M. C. Brown, B. Delgutte, F. Guenther, J. Melcher
9.05 Neural Basis of Movement  
Prereq: 9.01 or permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Spring)  
3-0-9  
Surveys general principles and specific examples of motor control in biological systems. Emphasizes the neural mechanisms underlying different aspects of movement and movement planning. Covers sensory reception, reflex arcs, spinal cord organization, pattern generators, muscle function, locomotion, eye movement, and cognitive aspects of motor control. Functions of central motor structures, including cerebellum, basal ganglia, and cerebral cortex. Cortical plasticity, motor learning and computational approaches to motor control, and motor disorders are discussed.  
A. Graybiel, M. Sur, E. Bizzi, C. Moore

9.07 Statistics for Brain and Cognitive Science  
Prereq: Calculus I (GIR), Calculus II (GIR); or permission of instructor  
U (Fall)  
3-0-9  
A survey introduction to statistical reasoning and statistical methods relevant to neuroscience and cognitive science research. Core topics include introductions to probability theory, estimation theory, hypothesis testing, linear models, the generalized linear model, and experimental design. Additional topics chosen from Monte Carlo methods, Bayesian methods, time-series analysis, spectral analysis, and point processes theory. Emphasis on developing a firm conceptual understanding of the statistical paradigm and statistical methods primarily through analyses of actual experimental data.  
E. N. Brown

9.073) Statistics for Neuroscience Research  
(Same subject as HST.460J)  
Prereq: 9.07 or permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Spring)  
3-0-9  
A survey of statistical methods for neuroscience research. Core topics include introductions to the theory of point processes, the generalized linear model, Monte Carlo methods, Bayesian methods, multivariate methods, time-series analysis, spectral analysis and state-space modeling. Emphasis on developing a firm conceptual understanding of the statistical paradigm and statistical methods primarily through analyses of actual experimental data.  
E. N. Brown

9.09J Cellular Neurobiology  
(Same subject as 7.29J)  
Prereq: 7.05  
U (Spring)  
4-0-8  
See description under subject 7.29J.  
W. G. Quinn, J. T. Littleton

9.10 Cognitive Neuroscience  
Prereq: 9.01  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Fall)  
3-0-9  
Explores the cognitive and neural processes that support attention, vision, language, motor control, navigation, and memory. Introduces basic neuroanatomy, functional imaging techniques, and behavioral measures of cognition. Discusses methods by which inferences about the brain bases of cognition are made. Considers evidence from patients with neurological disease (Alzheimer’s disease, Parkinson’s disease, Huntington’s disease, amnesia, and focal lesions from stroke) and from young and older individuals without neurological disease. Students prepare presentations summarizing journal articles and write one research proposal to conduct an experiment on a specific problem in cognitive neuroscience.  
S. Corkin

9.110) Molecular Pathology and Cognitive Sequelae of Age-dependent Neurological Disease  
(Same subject as 7.92J)  
Prereq: 9.011, 9.013, or permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Lectures and discussions explore the clinical, cognitive, and cellular-molecular aspects of brain aging processes. Topics include loss of memory and other cognitive capacities in normal aging and neurodegenerative conditions, with an emphasis on Alzheimer’s disease and associated mouse models. Other topics include neurodegenerative movement disorders, such as Parkinson’s and Huntington’s diseases. Based on lectures, readings from the primary literature, and discussions. Students are expected to present topics based on their readings. One written midterm test and one final examination.  
S. Corkin, L.-H. Tsai

9.12 Experimental Molecular Neurobiology  
Prereq: 9.01, Biology (GIR)  
U (Fall)  
2-4-6 Institute LAB  
Experimental techniques in cellular and molecular neurobiology. Designed for students without previous experience in techniques of cellular and molecular biology. Experimental approaches include tissue culture of neuronal cell lines, dissection and culture of brain cells, DNA manipulation, synaptic protein analysis, immunocytochemistry, and fluorescent microscopy. One lab session plus one paper review session per week. Enrollment limited.  
C. Lois

9.14 Brain Structure and Its Origins  
Prereq: 9.01  
U (Spring)  
3-0-9  
Outline of mammalian functional neuroanatomy, aided by studies of comparative neuroanatomy and evolution, and of brain development. Topics include early steps to a central nervous system, basic patterns of brain and spinal cord connections, regional development and differentiation, regeneration, motor and sensory pathways and structures, systems underlying motivations, innate action patterns, formation of habits, and various cognitive functions. Lab techniques reviewed. Optional brain dissections.  
G. E. Schneider

9.15 Biochemistry and Pharmacology of Synaptic Transmission  
(Subject meets with 9.150)  
Prereq: 9.01, 7.05, or permission of instructor  
Acad Year 2009–2010: U (Fall)  
Acad Year 2010–2011: Not offered  
3-0-9  
9.150 Biochemistry and Pharmacology of Synaptic Transmission  
(Subject meets with 9.15)  
Prereq: 9.011 or permission of instructor  
Acad Year 2009–2010: G (Fall)  
Acad Year 2010–2011: Not offered  
3-0-6 H-LEVEL Grad Credit  
Considers the process of neurotransmission, especially chemicals used in the brain and elsewhere to carry signals from nerve terminals to the structures they innervate. Focuses on monoamine transmitters (acetylcholine; serotonin; dopamine and norepinephrine); also examines amino acid and peptide transmitters and neuro-modulators like adenosine. Macromolecules that mediate neurotransmitter synthesis, release, inactivation and receptor-mediated actions are discussed, as well as factors that regulate their activity and the second-messenger systems and
ion fluxes that they control. The involvement of particular neurotransmitters in human diseases is considered.

R. J. Wurtman, K. Goosens

9.161 Cellular Neurophysiology
Prereq: 9.011 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Surveys the mechanisms of neuronal communication. Covers ion channels in excitable membranes, single cell computation, synaptic transmission, and synaptic plasticity. Correlates the properties of ion channels and synaptic transmission with their physiological function. Discusses the organizational principles for the formation of functional neural networks at synaptic and cellular levels. Involves discussion of primary literature. Juniors and seniors require instructor’s permission.

Staff

9.173J Noninvasive Imaging in Biology and Medicine
(Same subject as 20.483J, 22.56J, HST.561J)
Prereq: 18.03, 8.03, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 22.56J.

A. Jasanoff

9.18 Developmental Neurobiology
(Subject meets with 7.69, 9.181J)
Prereq: 9.01, 7.03, 7.05, or permission of instructor
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
4-0-8

9.181J Developmental Neurobiology
(Same subject as 7.69)
(Subject meets with 9.18)
Prereq: 9.011 or permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
4-0-8 H-LEVEL Grad Credit

Considers molecular control of neural specification, formation of neuronal connections, construction of neural systems, and the contributions of experience to shaping brain structure and function. Topics include: neural induction and pattern formation, cell lineage and fate determination, neuronal migration, axon guidance, synapse formation and stabilization, activity-dependent development and critical periods, development of behavior. In addition to final exam, analysis and presentation of research papers required for final grade. Additional readings required for graduate credit.

E. Nedivi

9.20 Animal Behavior
Prereq: 9.0.0 or permission of instructor
U (Fall)
3-0-9 HASS

Evolution of behavior, the driver of nervous system evolution, is reviewed emphasizing concepts developed in ethology and sociobiology. Examines foraging and feeding, defensive and aggressive behavior, courtship and reproduction, migration and navigation, and various social activities and communication. Students consider the contributions of inherited patterns and cognitive abilities as well as the roles of various types of plasticity. Both field and laboratory studies are reviewed; human behavior is considered in the context of primate studies.

G. E. Schneider

9.205 Biological Basis of Animal Behavior
Prereq: 9.011 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
2-0-7

Seminar explores the biological basis of animal behavior, focusing on its physiological and genetic mechanisms. Topics include genetic control of cast behavior in ants, navigation control in insects, specialization in cichlids, vocal learning in birds, magnetoreception in birds and mammals, genetic control of sexual preference in mammals, electrophoresis in fish, and pheromone perception in mammals. Critical reading of the relevant literature and presentations by the students. Limited to 10 students.

C. Lois

9.22J A Clinical Approach to the Human Brain
(Same subject as HST.422J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9

Introduction to normal and abnormal human brain functioning, including the cellular basis of activity-dependent development, critical periods, and plasticity of the brain through learning; neurotransmitters and emotional disorders; fMRI studies of vision, language, dyslexia, motor function, pain, placebo effects, and emotional states. Implications for education, prevention of dementia and dyslexia. Enrollment limited to 25.

T. N. Byrne

9.24J Diseases of the Nervous System
(Same subject as HST.424J)
Prereq: 9.01
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9

Topics examined include regional functional anatomy of the CNS through imaging and stroke; degenerative diseases such as Parkinson’s and Alzheimer’s; immunological disorders such as multiple sclerosis and paraneoplastic syndromes; epilepsy; and gliomas. Emphasis on diseases for which a molecular mechanism is understood. Clinical and pathological findings, differential diagnosis, genetics, pathophysiology, and treatment are discussed for individual diseases. Enrollment limited to 25.

T. N. Byrne

9.272J Topics in Neural Signal Processing
(Same subject as HST.576J)
Prereq: None
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9

Presents signal processing and statistical methods used to study neural systems and analyze neurophysiological data. Topics include state-space modeling formulated using the Bayesian Chapman-Kolmogorov system, theory of point processes, EM algorithm, Bayesian and sequential Monte Carlo methods. Applications include dynamic analyses of neural encoding, neural spike train decoding, studies of neural receptive field plasticity, algorithms for neural prosthetic control, EEG and MEG source localization. Students should know introductory probability theory and statistics.

E. N. Brown

9.285J Neural Coding and Perception of Sound
(Same subject as HST.723J)
Prereq: Permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit

See description under subject HST.723J.

B. Delgutte, M. C. Brown, J. J. Guinan, J. Melcher

9.29J Introduction to Computational Neuroscience
(Same subject as 8.261J)
Prereq: 18.03, Physics II (GIR); or permission of instructor
U (Fall)
3-0-9

Mathematical introduction to the biophysics and circuits underlying neural computation. Topics include neuronal excitability, dendrites
and cable theory, models of synaptic transmission, single-neuron dynamics, oscillators and sequence generation, and computation and dynamics in simple neuronal networks. Concepts applied to simple computing circuits in the behaving animal.

M. Fee

9.301J Neural Plasticity in Learning and Memory
(Same subject as 7.98J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

Examination of the role of neural plasticity during learning and memory of invertebrates and mammals. Detailed critical analysis of the current literature of molecular, cellular, genetic, electrophysiological, and behavioral studies. Student-directed presentations and discussions of original papers supplemented by introductory lectures. Juniors and seniors require instructor’s permission.

S. Tonegawa, M. Bear, W. Quinn, M. Wilson

9.31 The Neurophysiology of Memory
Prereq: 9.01
U (Fall)
4-0-8

Surveys the basic mechanisms supporting plasticity in neurons, focusing on how it contributes to learning in several systems. Examines cellular forms of associative plasticity, including long-term potentiation and depression, metaplasticity, homeostatic plasticity, and depotentiation. Relates these phenomena to associative memory, including classical conditioning in Aplysia, fear conditioning in rodents, eyeblink conditioning in rabbits, and striatal-based reward learning in rodents. Completion of 9.09 recommended.

K. Goosens

9.322J Genetic Neurobiology
(Same subject as 7.67J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

Specific functions of neurons, the interactions of neurons in development, and the organization of neuronal ensembles to produce behavior, by functional analysis of mutations and molecular analysis of their genes. Concentrates on work with nematodes, fruit flies, mice, and humans.

W. G. Quinn, J. T. Littleton

9.34 J Sensory and Social Orders
(Same subject as MAS.234J)
Prereq: 9.00 or permission of instructor
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-6

Explores how sensory and social systems engage in a variety of similar decision-making processes. Examines the use of partial orderings of alternative choices (or models) in interpreting available data, and how both use constraints to relate and narrow the choice options. Examples show how maximum likelihood equilibria depend upon context. Coverage includes important aspects of perception and cognition, decision-making in social systems, and elementary game theory.

W. A. Richards

9.343J Cognitive Architectures
(Same subject as MAS.654J)
Prereq: Permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit

Knowledge acquisition, communication, and successful behaviors require adequate models of the world. Actions based on such models depend on values assigned to state variables, which are derived from a creature’s beliefs and goals. How beliefs may be acquired, updated, or aggregated in decision-making is formalized using a graphical framework called an Anigraf. The framework is analogous to a society of agents with different beliefs and goals who strive to reach collective decisions for actions. Exposure to Bayesian, causal, analogical, logical, and game-theoretic frameworks also included.

W. A. Richards

9.35 Sensation and Perception
Prereq: Physics II (GIR) and Calculus II (GIR) or permission of instructor
U (Spring)
4-0-8

How senses work and how physical stimuli get transformed into signals in the nervous system. Examines how the brain uses those signals to determine what’s out there in the world. All the senses are discussed with emphasis on vision. Topics include perception of color, motion, form, and depth. Graduate students are expected to complete additional work.

E. H. Adelson

9.357 Special Topics in Vision Science
Prereq: Permission of instructor
G (Fall)
2-0-7 H-LEVEL Grad Credit
Can be repeated for credit

An advanced seminar on issues of current interest in human and machine vision. Topics vary from year to year. Participants discuss current literature as well as their ongoing research.

E. H. Adelson

9.364 Research in Cognitive Architectures
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit

Human models of the world are based on observed regularities in the behavior of events and actions. Such cognitive models play a dominant role not only in perception, but also in thought. Research projects address the structure of such models, and how they are manipulated and used.

W. A. Richards

9.37 J Anigrafs
(Same subject as MAS.235J)
Prereq: 9.34 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-6

Many complex systems can be represented as a society of agents who aggregate information to reach a collective decision. An Anigraf makes explicit how one agent’s knowledge is related to another’s, and how the form of these relationships affects the social choice. Simulations are used to discover emergent properties of different Anigraf models. Topics include elementary graph theory, network designs, partial orders, voting strategies, coordination games, and dynamics of choice. Applied examples taken from insect societies, neural networks, studies of co-evolution, cognition, and group decision-making.

W. A. Richards

9.41 Topics in Neuroscience and Cognitive Science
Prereq: One term of a faculty-sponsored research project for credit and permission of instructor
U (Fall)
2-12-4

Emphasizes research and scientific communication. Instruction and practice in written and oral communication provided. Based on his/her research, each student creates a full length paper and a poster as part of an oral presenta-
tion at the end of the course. Other assignments include reading and critiquing published research papers. Students must have collected enough data from their UROP research projects for development into a paper.

S. Jhaerri, M. Ögren, P. Sinha

9.422 Principles of Neuroengineering
(Same subject as 20.452J, MAS.881J)
Preq: 8.03, 6.003, and 9.01; or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject MAS.881J.
E. S. Boyden

9.433 Applications for Neuroengineering
(Same subject as MAS.882J)
Preq: MAS.881; or 6.003, 8.03, and 9.01.
Permission of instructor also required
G (Spring)
1-8-3 H-LEVEL Grad Credit
See description under subject MAS.882J.
E. S. Boyden

9.455 Neurotechnology Ventures
(Same subject as 15.128J, 20.454J, MAS.883J)
Preq: Permission of instructor
G (Fall)
2-0-7 H-LEVEL Grad Credit
See description under subject MAS.883J.
E. S. Boyden, R. Ellis-Behnke, J. Bonsen

9.472 Neuroimaging Cells and Circuits
(Same subject as 20.472J)
Preq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9
Offers an introduction to imaging methods at the forefront of modern neurobiology. Emphasis is placed on in vivo imaging in the context of neural systems research. Specific topics covered include classical optics, fluorescence and fluorescent dyes, multiphoton microscopy, reflectance-based imaging methods, functional and anatomical magnetic resonance imaging, and molecular neuroimaging. Both applications and underlying principles are discussed, and lectures are supplemented by demonstrations of imaging techniques in the laboratory. Enrollment limited to 15.
A. Jasanoff, P. T. So

9.481 Philosophical Issues in Brain Science
(Same subject as 24.08J)
Preq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS-D, Category 2, CI-H
See description under subject 24.08J.
A. Byrne, P. Sinha

9.50 Research in Brain and Cognitive Sciences
Preq: 9.00 or permission of instructor
U (Fall, Spring, Summer)
2-8-2 Institute LAB
Can be repeated for credit
Laboratory research in brain and cognitive science, using physiological, anatomical, pharmacological, developmental, behavioral, and computational methods. Each student carries out an experimental study under the direction of a member of the faculty. Project must be approved in advance by faculty supervisor and either M. Potter or P. H. Schiller. Written presentation of results is required.
Consult M. Potter or P. H. Schiller

9.51–9.52 Topics in Brain and Cognitive Sciences
Preq: 9.00 and any other two subjects in Brain and Cognitive Sciences
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Opportunity for undergraduate study in Brain and Cognitive Sciences not included in other subject listings.
Consult Department Headquarters

9.520 Statistical Learning Theory and Applications
Preq: 6.867, 6.041, 18.06, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Focuses on the problem of supervised and unsupervised learning from the perspective of modern statistical learning theory, starting with the theory of multivariate function approximation from sparse data. Develops basic tools such as regularization, including support vector machines for regression and classification. Derives generalization bounds using stability. Discusses current research topics such as manifold regularization, sparsity, feature selection, bayesian connections and techniques. Discusses applications in areas such as computer vision, speech recognition, and bioinformatics. Also covers advances in the neuroscience of the cortex and their impact on learning theory and applications. Exercises and final project.
T. Poggio, L. Rosasco

9.561 Abnormal Language
(Same subject as 24.907J)
Preq: 24.900 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9
Introduction to the linguistic study of language pathology, concentrating on experimental approaches and theoretical explanations. Discussion of Specific Language Impairment, Down syndrome, Williams’s syndrome, autism, normal aging, Parkinson’s disease, Alzheimer’s disease, hemispherectomy, and aphasia. Focuses on the comparison of linguistic abilities among these syndromes, while drawing clear comparisons with first- and second-language acquisition. Topics include the lexicon, morphology, syntax, semantics, and pragmatics. Relates the lost linguistic abilities in these syndromes to properties of the brain.
K. Wexler

9.571 Language Acquisition
(Same subject as 24.904J)
Preq: 24.900 or permission of instructor
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 HASS
Covers the major results in the study of first-language acquisition concentrating on the development of linguistic structure, including morphology, syntax, and semantics. Universal aspects of development are discussed, as well as a variety of cross-linguistic phenomena. Theories of language learning are considered, including parameter-setting and maturation.
K. Wexler

9.587 The Lexicon and Its Features
(Same subject as 6.543J, 24.941J, HST.727J)
Preq: 24.901 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 24.941J.
D. Gow, D. Steriade, S. Shattuck-Hufnagel
9.59j Psycholinguistics  
(Same subject as 24.905j)  
Prereq: 24.900 or permission of instructor or  
Coreq: 9.00  
G (Fall)  
3-0-6 H-LEVEL Grad Credit  
K. Wexler

Examines central topics in language processing, such as the structure and processing of language at multiple levels of analysis, including phonetics, words, sentences, intonation and discourse. Also discusses language acquisition and the relationship between language and thought. Emphasis on quantitative methods to investigate language, including reading and listening paradigms, neural imaging and computational modeling.  
E. Gibson

9.591j Language Processing  
(Same subject as 24.945j)  
Prereq: Permission of instructor  
G (Fall)  
3-0-6 H-LEVEL Grad Credit  
R. Saxe

Seminar in real-time language comprehension. Models of sentence and discourse comprehension from the linguistic, psychological, and artificial intelligence literature, including symbolic and connectionist models. Ambiguity resolution. Linguistic complexity. The use of lexical, syntactic, semantic, pragmatic, contextual, and prosodic information in language comprehension. The relationship between the computational resources available in working memory and the language processing mechanism. The psychological reality of linguistic representations.  
E. Gibson

9.60j Language Acquisition I  
(Same subject as 24.949j)  
Prereq: Permission of instructor  
G (Fall)  
3-0-6 H-LEVEL Grad Credit  
K. Wexler

Lectures, reading, and discussion of current theory and data concerning the psychology and biology of language acquisition. Emphasizes learning of syntax, semantics, and morphology, together with some discussion of phonology, and especially research relating grammatical theory and learnability theory to empirical studies of children.  

9.61 Laboratory in Higher Level Cognition  
Prereq: 9.07; 9.35, 9.59, 9.65, 9.66, 9.85, or permission of instructor  
U (Spring)  
3-6-3 Institute LAB  
M. C. Potter

How to design, conduct, analyze and present experiments on higher-level cognition. Students construct, conduct, analyze and present two experimental projects, including one original and independent experimental project of publishable quality. Exercises to develop skills in reading and writing scientific research reports in cognitive science cover evaluating the methods section of a published paper, reading and understanding graphical displays and statistical claims about data, and evaluating theoretical claims based on experimental data. Topics of research include social cognition and theory of mind, cognitive development, learning, induction, and moral cognition. Enrollment limited to 18.  
E. Gibson

9.611j Natural Language and the Computer Representation of Knowledge  
(Same subject as 6.863j)  
Prereq: 6.034  
G (Spring)  
3-3-6 H-LEVEL Grad Credit  
R. C. Berwick

See description under subject 6.863j.  

9.63 Laboratory in Visual Cognition  
Prereq: 9.07; 9.00, 9.01, or permission of instructor  
U (Fall)  
3-6-3 Institute LAB  
H. S. Seung

Teaches principles of experimental methods in human visual perception and attention, including how to design, conduct, analyze, and present experiments in visual cognition. Combines lectures and hands-on experimental exercises. Requires two experimental projects, at least one of which is conducted independently; the other may be done as part of a team. To foster improved writing and presentation skills in conducting and critiquing research in cognitive science, students are required to provide several individual reports on experimental designs, as well as to write articles and give oral presentations critiquing three team experiments observed in class. Experience with MATLAB is recommended. Enrollment limited to 18.  
A. Oliva

9.641j Introduction to Neural Networks  
(Same subject as 8.594j)  
Prereq: 9.29 or permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
J. B. Tenenbaum

H. S. Seung

9.65 Cognitive Processes  
Prereq: None. Coreq: 9.00  
U (Spring)  
3-0-9 HASS  
M. C. Potter

An introduction to human information processing and learning. Topics include the nature of mental representation and processing; the architecture of memory; pattern recognition; attention; imagery and mental codes; concepts and prototypes; reasoning and problem-solving.  

9.66j Computational Cognitive Science  
(Same subject as 6.804j)  
(Subject meets with 9.660)  
Prereq: 9.07, 18.05, 6.041, or permission of instructor  
U (Spring)  
3-0-9  
J. B. Tenenbaum

Introduction to computational theories of human cognition. Focuses on principles of inductive learning and inference, and the representation of knowledge. Computational frameworks include Bayesian and hierarchical Bayesian models, probabilistic graphical models, non-parametric statistical models and the Bayesian Occam’s razor, sampling algorithms for approximate learning and inference, and probabilistic models defined over structured representations such as first-order logic, grammars, or relational schemas. Applications to understanding core aspects of cognition, such as concept learning and categorization, causal reasoning, theory formation, language acquisition, and social inference. Graduate students complete a final project.
9.675 The Development of Object and Face Recognition
Prereq: 9.012 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

A ‘back to the beginning’ view to better understand the end result. What might be the developmental processes that lead to the organization of ‘booming, buzzing confusions’ into coherent visual objects? Examines key experimental results and computational proposals pertinent to the discovery of objects in complex visual inputs. In-depth discussions of research articles. Enrollment limited to 15.

P. Sinha

9.68 Affect: Biological, Psychological, and Social Aspects of “Feelings”
Prereq: 9.00
U (Spring)
2-2-8 HASS

Affect is to cognition and behavior as feeling is to thinking and acting or as values are to beliefs and practices. Considers these relations, both at the psychological level of organization and in terms of their neurobiological and sociocultural counterparts. In addition to attending weekly class sessions and doing regular homework assignments, students are required to participate in small study groups that meet for two hours per week.

S. L. Chorover

9.691 Introduction to Connectomics (New)
Prereq: None
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-6

Covers the emerging field of connectomics, with an emphasis on tools for high-throughput generation of data about neural connectivity. Topics include nanoscale imaging, including electron microscopy and sub-diffraction-limt fluo- rescence microscopy; nanoscale and microscale cutting; fluorescent and electron-dense staining; and image analysis algorithms. Case studies cover areas such as C. elegans, neuromuscular junction, retina, and cortex.

H. S. Seung

9.70 Social Psychology
Prereq: None
U (Spring)
3-2-7 HASS

Examines interpersonal and group dynamics, considers how the thoughts, feelings, and actions of individuals are influenced by (and influence) the beliefs, values, and practices of large and small groups. Learning occurs through a combination of in-class activities complemented by participation in small study groups and completion of regular homework assignments. Also involves occasional lectures and demonstrations.

S. L. Chorover

9.71 Functional MRI of High-Level Vision
Prereq: 9.07; 9.34, 9.35, 9.65, 9.66, or permission of instructor
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9

Basics of fMRI, the strengths and limitations of fMRI compared to other techniques, and the design and analysis of fMRI experiments, focusing primarily on experiments on high-level vision. Students write papers and give presentations, explain and critique published papers, and design but do not conduct their own fMRI experiments. Upon completion, students should be able to understand and critique published fMRI papers and have a good grasp of what is known about high-level vision from fMRI. Enrollment limited to 12.

N. G. Kanwisher

9.720 The Neural Basis of Visual Object Recognition in Monkeys and Humans
Prereq: None
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9

Key issues of object representation and data from primate physiology and human fMRI that bear on those issues. Topics include computational problems of object representation, the nature of object representations in the brain, tolerance and selectivity of those representations, and the effects of attention and learning. Enrollment limited to 15.

J. J. DiCarlo, N. G. Kanwisher

9.75 Psychology of Gender and Race
(Same subject as SP.650J)
Prereq: None
U (Fall, Spring)
3-0-9 HASS

Examines evidence (and lack thereof) regarding when and how an individual’s thoughts, feelings, and actions are affected by gender and race. Topics include gender and racial factors in identity development, cognition and emotion, achievement, stereotypes, physical and mental health, sexuality, close relationships, work, and violence. Enrollment limited to 20.

C. Kapungu

9.77 Computational Perception (New)
Prereq: 9.01, 9.00, 9.07; 9.65 or 9.35; or permission of instructor
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9

9.777 Computational Perception (New)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-6

Begins with a review of the experimental paradigms, findings and theories used to evaluate the capabilities and limits of the human brain. Assesses how knowledge of human perception may be used to guide machine vision systems. Second part of the subject focuses on models in computational perception. Describes how computer vision systems, inspired by the human brain, can perform image analysis and synthesis; face, object and scene perception; texture synthesis, segmentation, and navigation. Introduces various simulation methods. A MATLAB-based project in computational perception is required. Limited to 12.

A. Oliva

9.85 Infant and Early Childhood Cognition
Prereq: 9.00
U (Fall)
3-0-9 HASS

Introduction to cognitive development focusing on children's understanding of objects, agents, and causality. Develops a critical understanding of experimental design. Discusses how developmental research might address philosophical questions about the origins of knowledge, appearance and reality, and the problem of other minds. Provides instruction and practice in written communication as necessary to research in cognitive science (including critical reviews of journal papers, a literature review and an original research proposal), as well as instruction and practice in oral communication in the form of a poster presentation of a journal paper.

L. Schulz

9.91 Topics in Brain and Cognitive Sciences
Prereq: 9.00 and any other two subjects in Brain and Cognitive Sciences
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Individual study of a special topic under the direction of a member of the faculty.

Consult Department Headquarters
9.911–9.917 Special Topics in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for graduate study of advanced subjects in Brain and Cognitive Sciences not included in other subject listings. 9.911 is taught P/D/F.
Staff

9.919 Teaching Brain and Cognitive Sciences
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit
For teaching assistants in Brain and Cognitive Sciences, in cases where teaching assignment is approved for academic credit by the department.
Staff

9.92 Topics in Brain and Cognitive Sciences
Prereq: 9.00
U (Fall, Spring)
Units arranged
Can be repeated for credit
Opportunity for undergraduate study in Brain and Cognitive Sciences not included in other subject listings.
Consult Department Headquarters

9.921 Research in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Guided research under the sponsorship of individual members of the faculty. Ordinarily restricted to candidates for the doctoral degree in Course 9.
Staff

9.941 Graduate Thesis Proposals
Prereq: 9.931
G (Fall, Spring, Summer)
0-0-6 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Course 9 graduate students submit written proposals for thesis according to stated deadlines. Registration is mandatory in Fall term of the fourth year.
Staff

9.93—9.99 Independent Activities
Prereq: None
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit
For undergraduates taking Course 9 IAP subjects for credit. See IAP Guide for details.
Consult Department Headquarters

9.ThG Graduate Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research leading to the writing of a PhD thesis; to be arranged by the student and an appropriate MIT faculty member.
Staff

9.JRG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Individual participation in an ongoing research project.
Consult Department Headquarters

PSYCHOLOGY

The undergraduate program in Psychology is described in the MIT Bulletin (Course Catalog).
# Bachelor of Science in Brain and Cognitive Sciences/Course 9

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [three subjects can be satisfied by 9.00 and two other HASS subjects in the Departmental Program]</td>
<td>6</td>
<td>126–132</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [one subject can be satisfied by 9.01 in the Departmental Program]</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by a laboratory in the Departmental Program]</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td>17</td>
<td></td>
</tr>
</tbody>
</table>

## Communication Requirement

The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M).

## PLUS Departmental Program

**Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).**

### Required Subjects

- 9.00 Introduction to Psychology, 12, HASS
- 9.01 Introduction to Neuroscience, 12, REST; Physics II (GIR)
- 9.07 Statistics for Brain and Cognitive Sciences, 12; Calculus II (GIR)*

### Core Subjects

Choose six subjects from three areas: cognitive science, cognitive neuroscience, and neuroscience. Any combination of subjects is permitted, but at least one subject must be chosen in a second area.

#### Cognitive Science

- 9.34 Sensory and Social Orders, 9; 9.00*
- 9.37 Anigrafs, 9; 9.34*
- 9.56 Abnormal Language, 12; 24.900*
- 9.57 Language Acquisition, 12, HASS; 24.900*
- 9.59 Psycholinguistics, 12, HASS; 24.900* or 9.00
- 9.61 Cognitive Processes, 12, HASS; 9.00
- 9.64 Computational Cognitive Science, 12; 9.07, 18.05, 6.041, or permission of instructor
- 9.85 Infant and Early Childhood Cognition, 12, CI-M; 9.00
- 24.900 Introduction to Linguistics, 12, HASS-D, CI-H

#### Cognitive Neuroscience

- 9.10 Cognitive Neuroscience, 12; 9.01
- 9.20 Animal Behavior, 12, HASS; 9.00*
- 9.22A A Clinical Approach to the Human Brain, 12
- 9.35 Sensation and Perception, 12; Physics II (GIR), Calculus II (GIR); or permission of instructor
- 9.71 Functional MRI of High-Level Vision, 12, CI-M; 9.07; 9.34, 9.35, 9.65, 9.66, or permission of instructor

#### Neuroscience

- 9.03 Neural Basis of Learning and Memory, 12; 9.01
- 9.04 Neural Basis of Vision and Audition, 12; 9.01*
- 9.05 Neural Basis of Movement, 12; 9.01*
- 9.09 Cellular Neurobiology, 12; 7.05
- 9.14 Brain Structure and Its Origins, 12, 9.01
- 9.15 Biochemistry and Pharmacology of Synaptic Transmission, 12; 9.01, 7.05, or permission of instructor
- 9.18 Developmental Neurobiology, 12, CI-M; 9.01, 7.03, 7.05, or permission of instructor
- 9.24A Diseases of the Nervous System, 12; 9.01
- 9.29A Introduction to Computational Neuroscience, 12; 18.03, Physics II (GIR); or permission of instructor
- 9.31 Neurophysiology of Memory, 12; 9.01

### Laboratory

One of the following is required:

- 9.02 Systems Neuroscience Laboratory, 12, LAB, CI-M; 9.01
- 9.12 Experimental Molecular Neurobiology, 12, LAB, CI-M; 9.01, Biology (GIR)
- 9.61 Laboratory in Higher-Level Cognition, 12, LAB, CI-M; 9.07; 9.35, 9.59, 9.66, 9.65, 9.85, or permission of instructor
- 9.63 Laboratory in Visual Cognition, 12, LAB, CI-M; 9.07; 9.00, 9.01, or permission of instructor

Plus one of the following:

- 9.URG Undergraduate Research, 12
- 9.02 Brain Laboratory, 12, LAB, CI-M; 9.01
- 9.12 Experimental Molecular Neurobiology, 12, LAB, CI-M; 9.01, Biology (GIR)
- 9.41 Topics in Neuroscience and Cognitive Science, 18, CI-M; 9.URG
- 9.50 Research in Brain and Cognitive Sciences, 12, LAB; 9.00*
- 9.61 Laboratory in Higher-Level Cognition, 12, LAB, CI-M; 9.07; 9.35, 9.59, 9.66, 9.65, 9.85, or permission of instructor
- 9.63 Laboratory in Visual Cognition, 12, LAB, CI-M; 9.07; 9.00, 9.01, or permission of instructor
<table>
<thead>
<tr>
<th><strong>Restricted Electives</strong></th>
<th>21–24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two relevant subjects to be arranged with the student’s advisor.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Departmental Program Units That Also Satisfy the GIRs</strong></th>
<th>(36–45)</th>
</tr>
</thead>
</table>

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<tr>
<th><strong>Unrestricted Electives(^{(1)})</strong></th>
<th>60–69</th>
</tr>
</thead>
</table>

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<thead>
<tr>
<th><strong>Total Units Beyond the GIRs Required for SB Degree</strong></th>
<th>180</th>
</tr>
</thead>
<tbody>
<tr>
<td>No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.</td>
<td></td>
</tr>
</tbody>
</table>

**Notes**

*Alternate prerequisites are listed in the subject description

\(^{(1)}\) Additional elective units may be available to the extent the General Institute Requirements are fulfilled by subjects taken in the department program.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
10.04j A Philosophical History of Energy
(Same subject as 24.114j)
Prereq: None
U (Spring)
3-0-9 HASS
Philosophic and historical approach to conceptions of energy through the 19th century. Relation of long standing scientific and philosophic problems in the field of energy to 21st-century debates. Topics include the development of thermodynamics and kinetic theories, the foundation of the scientific project, the classical view of energy, and the harnessing of nature. Authors include Bacon, van Boltzmann, Carnot, Compte, Descartes, Gibbs, Plato, Aristotle, Leibniz, Kant, Hegel, Mill, Perice, Whitehead, and Maxwell. Key texts and controversies form topics of weekly writing assignments and term papers.
B. L. Trout, L. D. Perlman

10.10 Introduction to Chemical Engineering
Prereq: Chemistry (GIR), Physics I (GIR), Calculus I (GIR)
U (Fall, Spring)
4-0-8
The diverse applications of chemical engineering are explored through example problems. Solutions require application of fundamental concepts of mass and energy conservation to batch and continuous systems, involving chemical and biological processes. Computer skills and the elements of engineering design are taught in the context of these example problems. The objective is to acquaint the student with the field of chemical engineering and to enable use of computer methods to solve chemical and biological engineering problems.
Geo. Stephanopoulos, K. J. Prather, B. S. Johnston, G. C. Rutledge

10.213 Chemical and Biological Engineering Thermodynamics
Prereq: 5.60, 10.10
U (Spring)
4-0-8
Thermodynamics of multicomponent, multiphase chemical and biological systems. Applications of first, second, and third laws of thermodynamics to open and closed systems. Properties of mixtures, including colligative properties, chemical reaction equilibrium, and phase equilibrium; non-ideal solutions; power cycles; refrigeration; separation systems.
K. K. Gleason, N. Maheshri, J. C. Love

10.22 Molecular Engineering
Prereq: 5.60, 10.213
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9
Introduces molecular concepts in relation to engineering thermodynamics. Includes topics in statistical mechanics, molecular description of gases and liquids, property estimation, description of equilibrium and dynamic properties of fluids from molecular principles, and kinetics of activated processes. Also covers some basic aspects of molecular simulation and applications in systems of engineering interest.
G. C. Rutledge, P. S. Doyle

10.25 Industrial Chemistry and Chemical Process Pathways
Prereq: Chemistry (GIR), 10.213, 10.37
G (Fall)
3-0-6 H-LEVEL Grad Credit
Chemical and engineering principles involved in creation and operation of viable industrial processes. Topics: analysis of process chemistry by p-pathways (i.e., radical, ionic, and pericyclic reactions of organic syntheses) and d-pathways (i.e., catalysis by transition-metal complexes). Use of reaction mechanisms for inference of co-product formation, kinetics, and equilibria: process synthesis logic related to reaction selectivity, recycle, separations. Illustrations drawn from current and contemplated commercial practice.
P. S. Virk

10.26 Chemical Engineering Projects Laboratory
(Subject meets with 10.29)
Prereq: 5.310, 7.02, or 10.702; 10.302
U (Spring)
3-8-4
Projects in applied chemical engineering research. Students work in teams on one project for the term. Projects often suggested by local industry. Includes training in research planning and project management, execution of experimental work, data analysis, oral presentation skills and individual report writing, and teambuilding.

10.28 Chemical-Biological Engineering Laboratory
Prereq: 5.310, 7.02, or 10.702; 7.05 or 5.07; or permission of instructor
U (Fall)
2-8-5
Credit cannot also be received for 10.28L Introduces the complete design of the bioprocess: from vector selection to production, separation, and characterization of recombinant products. Utilize concepts from many fields, such as, chemical and electrical engineering, and biology. Student teams work through parallel modules spanning microbial fermentation and animal cell culture. With the bioreactor at the core of the experiments, students study cell metabolism and biological pathways, kinetics of cell growth and product formation, oxygen mass transport, scale-up and techniques for the design of process control loops. Introduces novel bioreactors and powerful analytical instrumentation. Downstream processing and recombinant product purification also included. Enrollment limited.
J.-F. Hamel and K. J. Prather

10.28L Chemical-Biological Engineering Laboratory
Prereq: 5.310, 7.02, or 10.702; 7.05 or 5.07; or permission of instructor
U (IAP, Spring)
2-8-5
Credit cannot also be received for 10.28L

Same as 10.28, but with the lab portion of the class held during IAP. Content, depth, and difficulty are otherwise identical to that of 10.28. The class is designated as 10.28 on students’ transcripts. Enrollment limited.
J.-F. Hamel and Staff
10.29 Biological Engineering Projects Laboratory
(Subject meets with 10.26)
Prereq: 5.310, 7.02, or 10.702; 10.302
U (Spring)
3-8-4
Projects in applied biological engineering research. Students work in teams on one project for the term. Projects often suggested by local industry. Includes training in research planning and project management, execution of experimental work, data analysis, oral presentation skills and report writing, and team-building.
C. K. Colton, J. F. Hamel, C. L. Cooney,
R. S. Langer, N. Maheshri

10.30 Fluid Mechanics
Prereq: 18.03, 10.10
U (Spring)
3-0-6
W. M. Deen, A. K. Chakraborty

10.302 Transport Processes
Prereq: 5.60, 10.301, 10.213; or permission of instructor
U (Fall)
3-0-6
Principles of heat and mass transfer. Steady and transient conduction and diffusion. Radiative heat transfer. Convective transport of heat and mass in both laminar and turbulent flows. Emphasis on the development of a physical understanding of the underlying phenomena and upon the ability to solve real heat and mass transfer problems of engineering significance.
W. H. Dalzell, T. A. Hatton

10.32 Separation Processes
Prereq: 10.213, 10.302
U (Spring)
2-0-4
General principles of separation by equilibrium and rate processes. Staged cascades. Applications to distillation, absorption, adsorption, and membrane processes. Use of material balances, phase equilibria, and diffusion to understand and design separation processes.
W. H. Dalzell

10.33 Introduction to Modeling and Simulation
Prereq: 10.213, 10.301, 10.333, 22.081
U (Spring)
4-0-8 REST
See description under subject 3.021.
M. Buehler, N. Marzari, R. Radovitzky,
T. Thonhauser

10.34 Numerical Methods Applied to Chemical Engineering
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Numerical methods for solving problems arising in heat and mass transfer, fluid mechanics, chemical reaction engineering, and molecular simulation. Topics: numerical linear algebra, solution of nonlinear algebraic equations and ordinary differential equations, solution of partial differential equations (e.g. Navier-Stokes), numerical methods in molecular simulation (dynamics, geometry optimization). All methods are presented within the context of chemical engineering problems. Familiarity with structured programming is assumed.
W. H. Green

10.37 Chemical Kinetics and Reactor Design
Prereq: 5.60, 10.301
U (Spring)
3-0-6
Applies the concepts of reaction rate, stoichiometry and equilibrium to the analysis of chemical and biological reacting systems. Derivation of rate expressions from reaction mechanisms and equilibrium or steady state assumptions. Design of chemical and biochemical reactors via synthesis of chemical kinetics, transport phenomena, and mass and energy balances. Topics: chemical/biological pathways; enzymatic, pathway and cell growth kinetics; batch, plug flow and well-stirred reactors for chemical reactions and cultivations of microorganisms and mammalian cells; heterogeneous and enzymatic catalysis; heat and mass transport in reactors, including diffusion to and within catalyst particles and cells or immobilized enzymes.
G. Stephanopoulos, K. D. Wittrup, W. H. Green

10.39J Sustainable Energy
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 22.812.
W. M. Golay, J. P. Freidberg

10.392J Fundamentals of Advanced Energy Conversion
Prereq: Permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
See description under subject 2.62J.
A. F. Ghoniem, M. Kazimi, Y. Chiang

10.393 Multiscale Analysis of Advanced Energy Processes
Prereq: Permission of instructor
G (Spring)
Units arranged H-LEVEL Grad Credit
Motivation, approach and overall methodology, and specific options for achieving a more sustainable energy supply with lower environmental impacts. Case studies designed to explore multiscale aspects of new energy technology development. Four, 2-week subject modules explore diverse aspects of new energy technology development. Modules include nuclear power for electricity and hydrogen production, conventional and synthetic fossil fuels and carbon sequestration, conversion of biomass into transportation fuels and energy, and geothermal energy recovery and conversion to electricity.
M. Golay, E. Drake

10.40 Chemical Engineering Thermodynamics
Prereq: 5.60, 10.213
G (Fall)
4-0-8 H-LEVEL Grad Credit
Basic postulates of classical thermodynamics. Application to transient open and closed systems. Criteria of stability and equilibria. Constitutive property models of pure materials and mixtures emphasizing molecular-level effects using the formalism of statistical mechanics. Phase and chemical equilibria of multicomponent systems. Applications emphasized through
extensive problem work relating to practical cases.

D. Blankschtein, A. K. Chakraborty

10.420 Molecular Aspects of Chemical Engineering
(Subject meets with 10.520)
Prereq: 5.13, 10.213
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-6 H-LEVEL Grad Credit

Meets with subject 10.520, but assignments differ.

P. T. Hammond

10.43 Introduction to Interfacial Phenomena
Prereq: 10.213 or introductory subject in thermodynamics or physical chemistry
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-6 H-LEVEL Grad Credit


D. Blankschtein

10.44 Statistical Thermodynamics of Complex Liquids
(Subject meets with 8.575J, 22.52J)
Prereq: 8.08, 10.213
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit

Theory of self-assembly in surfactant-water (micellar) and surfactant-water-oil (micro-emulsion) systems. Introduction to the theory of polymer solutions. Introduction to scattering techniques, light, x-ray, and neutron scattering applied to studies of the structure and dynamics of complex liquids. Modern theory of the liquid state relevant to structured (supramolecular) liquids.

D. Blankschtein, S. H. Chen

10.441J Molecular and Engineering Aspects of Biotechnology
(Subject meets with 7.37J, 20.361J)
Prereq: 20.110J, 2.005, 3.012, or 5.60; 7.06; or permission of instructor
U (Spring)
4-0-8

See description under subject 7.37J.

H. Lodish, L. G. Griffith

10.442 Biochemical Engineering
(Subject meets with 10.542)
Prereq: Permission of instructor
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-6

See description under subject 10.542.

K. J. Prather

10.445 Separation Processes for Biochemical Products
(Subject meets with 10.545)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-6

See description under subject 10.545.

C. L. Cooney

10.450 Process Dynamics, Operations, and Control
Prereq: 10.302, 18.03
U (Spring)
3-0-6

Introduction to dynamic processes and the engineering tasks of process operations and control. Subject covers modeling the static and dynamic behavior of processes; control strategies; design of feedback, feedforward, and other control structures; model-based control; applications to process equipment.

B. S. Johnston

10.467 Polymer Science Laboratory
Prereq: 5.12, 5.310
U (Fall)
2-7-6 Institute LAB

Experiments broadly aimed at acquainting students with the range of properties of polymers, methods of synthesis, and physical chemistry. Examples: solution polymerization of acrylamide, bead polymerization of divinylbenzene, interfacial polymerization of nylon 6,10. Evaluation of networks by tensile and swelling experiments. Rheology of polymer solutions and suspensions. Physical properties of natural and silicone rubber. Priority of enrollment given to Course 10 seniors and juniors.

P. T. Hammond, G. C. Rutledge, J. C. Love

10.490 Integrated Chemical Engineering I
Prereq: 10.37
U (Fall)
3-0-5

10.491 Integrated Chemical Engineering II
Prereq: 10.490
U (Spring)
3-0-5

Presents and solves chemical engineering problems in an industrial context, with applications varying by term. Emphasis on the integration of fundamental concepts with approaches of process design. Emphasis on problems that demand synthesis, economic analysis, and process design.

P. I. Barton, G. J. McRae, B. S. Johnston

10.492 Integrated Chemical Engineering Topics I
Prereq: 10.490 or 10.491
U (Fall)
2-0-2

10.493 Integrated Chemical Engineering Topics II
Prereq: 10.490 or 10.491
U (IAP)
2-0-2

10.494 Integrated Chemical Engineering Topics III
Prereq: 10.490 or 10.491
U (Spring)
2-0-2

Chemical engineering problems presented and analyzed in an industrial context. Emphasis on the integration of fundamentals with material property estimation, process control, product development, and computer simulation. Integration of societal issues, such as engineering ethics, environmental and safety considerations, and impact of technology on society are addressed in the context of case studies.


10.495 Molecular Design and Bioprocess Development of Immunotherapies (New)
(Subject meets with 10.595)
Prereq: 7.06 or permission of instructor
U (Spring)
3-0-6

Examines challenges and opportunities for applying chemical engineering principles to address the growing global burden of infectious disease, including drug-resistant strains and neglected pathogens. Topics include a historical overview of vaccines and immunotherapies, the molecular design considerations
for new immunotherapies and adjuvants, the economic challenges for process development and manufacturing of immunotherapies, and new technologies for designing and assessing therapies. Case studies to cover topics for specific diseases. Students taking graduate version complete additional assignments.

J. C. Love

10.499J Tissue Engineering for Analysis, Prevention, and Treatment of Human Disease
(Subject meets as 20.360J)
Prereq: 5.07 or 7.05; 7.03; 18.03; 20.110 or 5.60 Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring) 3-0-6
See description under subject 20.360J.

K. D. Wittrup, B. Tidor

10.50 Analysis of Transport Phenomena
Prereq: 10.301, 10.302 G (Fall)
4-0-8 H-LEVEL Grad Credit
Unified treatment of heat transfer, mass transfer, and fluid mechanics, emphasizing scaling concepts in formulating models and analytical methods for obtaining solutions. Topics include conduction and diffusion, laminar flow regimes, convective heat and mass transfer, and simultaneous heat and mass transfer with chemical reaction or phase change.

W. M. Deen, P. S. Doyle

10.52 Mechanics of Fluids
Prereq: 10.50 G (Fall)
3-0-6 H-LEVEL Grad Credit
Advanced subject in fluid and continuum mechanics. Content includes kinematics, macroscopic balances for linear and angular momentum, the stress tensor, creeping flows and the lubrication approximation, the boundary layer approximation, linear stability theory, and some simple turbulent flows.

K. A. Smith

10.520 Molecular Aspects of Chemical Engineering
(Subject meets with 10.420)
Prereq: 5.13, 10.213, Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring) 3-0-6 H-LEVEL Grad Credit
Molecular-level engineering and analysis of chemical processes. Use of chemical bonding, reactivity, and other key concepts in the design and tailoring of organic systems. Application and development of structure-property relationships. Descriptions of the chemical forces and structural factors that govern supramolecular and interfacial phenomena for molecular and polymeric systems.

P. T. Hammond

10.521 Heterogeneous Catalysis and Catalytic Processes
Prereq: 5.13, 10.37 G (Fall)
3-0-6 H-LEVEL Grad Credit
An introduction to applied catalysis, focusing on principles of importance in the development and improvement of catalysts and their practical use in industry. Topics include adsorption phenomena, catalyst preparation, and surface characterization techniques. Application of catalyst functionality concepts for control of reaction selectivity and kinetic models. Commonality of mechanisms for significant groups of catalyzed reactions such as hydrogenation, partial oxidation, and hydrocarbon reactions catalyzed by solid acids and zeolites. Control of pollutant emissions by catalysis.

Staff

10.531J Macromolecular Hydrodynamics
(Subject meets as 2.341J)
Prereq: 2.25, 10.301, or permission of instructor Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered 3-0-6 H-LEVEL Grad Credit

R. C. Armstrong, G. H. McKinley

10.534 Macrotransport Processes
Prereq: 10.50 G (Fall)
3-0-6 H-LEVEL Grad Credit
Generalized Taylor dispersion theory applied to chromatographic separation processes, flow and transport in porous media, transport properties of macromolecular solutions, and generic analyses of heterogeneous systems, including adsorption phenomena, thermal transport processes, and chemically reactive continua.

Staff

10.535 Interfacial Transport Processes and Rheology
Prereq: 10.50 G (Fall)
3-0-6 H-LEVEL Grad Credit
Introduction to the theory and applications of liquid-liquid interfacial transport phenomena. General tensor analysis; interfacial statics; kinematics, and transport across and within curved, deforming interfaces; two-dimensional momentum transport processes, Newtonian and non-Newtonian interfacial stress constitutive relations, applications to surface rheology; surfactant transport and adsorption at interfaces, surface diffusion, Marangoni phenomena, interphase mass transfer; asymptotic theory of diffuse interfaces; line tension phenomena.

Staff

10.536J Thermal Hydraulics in Power Technology
(Subject meets as 2.59J, 22.313J)
Prereq: 2.006, 10.302, 22.312, or permission of instructor Acad Year 2009–2010: Not offered Acad Year 2010–2011: G (Spring) 3-2-7 H-LEVEL Grad Credit
See description under subject 22.313J.

M. S. Kazimi, N. E. Todreas

10.537J Molecular, Cellular, and Tissue Biomechanics
(Subject meets as 2.798J, 3.971J, 6.524J, 20.410J)
Prereq: Biology (GIR); 2.002, 2.006, 6.013, 10.301, or 10.302 G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.410J.

A. J. Grodzinsky, M. Bathe

10.538J Biomolecular Kinetics and Cellular Dynamics
(Subject meets as 20.420J)
Prereq: 7.05, 7.06, 18.03 G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.420J.

K. D. Wittrup, B. Tidor
10.539| Fields, Forces, and Flows in Biological Systems
(Same subject as 2.795J, 6.561J, 20.430J, HST.544J)
Prereq: 6.013, 2.005, 10.302, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.430).
A. J. Grodzinsky, D. Lauffenburger

10.540 Intracellular Dynamics
Prereq: 18.03, 7.06, 10.302, or permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Covers current models and descriptions of the internal cell dynamics of macromolecules due to reaction and transport. Explores two major areas: the process of gene expression, including protein-DNA interactions, chromatin dynamics, and the stochastic nature of gene expression; and cell signaling systems, especially those that lead to or rely on intracellular protein gradients. Intended for graduate students or advanced undergraduates with some background in cell biology, transport, and kinetics. An introductory class in probability is recommended. N. Maheshri

10.541 Kinetics of Biological and Chemical Systems
Prereq: 10.37 or permission of instructor
G (Fall)
6-0-6 H-LEVEL Grad Credit
Comprehensive treatment of the kinetics of basic chemical reactions and biological processes. Subject begins with a fundamental analysis of reaction order in homogeneous reactions and proceeds with the kinetics of heterogeneous systems and catalytic reactions. Methods of measuring and calculating reaction rate constants included. After a basic stoichiometric analysis of biological reaction networks, the subject discusses kinetics of enzymatic reactions and extensions to kinetic characteristics of reaction pathways and bioreactor networks. Similarities and differences between chemical and biological kinetics discussed along with concepts of rate-limiting steps and distribution of control among several reactions in a pathway. Subject concludes with applications to the kinetic analysis of chemical and biological reaction systems in the chemical and bioprocess industries. B. L. Trout, Gr. Stephanopoulos

10.542 Biochemical Engineering
(Subject meets with 10.442)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit
Interaction of chemical engineering, biochemistry, and microbiology. Mathematical representations of microbial systems. Kinetics of growth, death, and metabolism. Continuous fermentation, agitation, mass transfer, and scale-up in fermentation systems, enzyme technology. K. J. Prather

10.543J Protein Folding and Human Disease
(Same subject as 5.48J, 7.88J)
Prereq: 7.51 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 7.88J.
S. Lindquist, J. A. King

10.544 Metabolic and Cell Engineering
Prereq: 5.60, 7.05, 10.302, 18.03
G (Fall)
3-0-6 H-LEVEL Grad Credit
Presentation of a framework for quantitative understanding of cell functions as integrated molecular systems. Analysis of cell-level processes in terms of underlying molecular mechanisms based on thermodynamics, kinetics, mechanics, and transport principles, emphasizing an engineering, problem-oriented perspective. Objective is to rationalize target selection for genetic engineering and evaluate the physiology of recombinant cells. Topics include cell metabolism and energy production, transport across cell compartment barriers, protein synthesis and secretion, regulation of gene expression, transduction of signals from extracellular environment, cell proliferation, cell adhesion and migration. Gr. Stephanopoulos

10.545 Separation Processes for Biochemical Products
(Subject meets with 10.445)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-6 H-LEVEL Grad Credit
Introduction to fundamental principles of separation operations for the recovery of products from biological processes, membrane filtration, chromatography, centrifugation, cell disruption, extraction, and process design. C. L. Cooney

10.546J Statistical Thermodynamics
(Same subject as 5.70J)
Prereq: 5.60 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 5.70J.
J. Cao

10.547J Principles and Practice of Drug Development
(Same subject as 7.547J, 15.136J, ESD.691J, HST.920J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject 15.136J.
T. J. Allen, C. L. Cooney, S. N. Finkelstein, R. H. Rubin, A. J. Sinskey

10.548J Tumor Pathophysiology and Transport Phenomena: A Systems Biology Approach
(Same subject as HST.525J)
Prereq: 18.03; 10.301
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
2-0-4 H-LEVEL Grad Credit
See description under subject HST.525J.
R. K. Jain

10.55 Colloid and Surfactant Science
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Introduction to theory and applications of colloidal dispersions and surfactant science. Monolayer adsorption at interfaces, electrical double layers, dispersion forces, electrokinetic phenomena, and stabilization of dispersions. Chemistry, structure, and classification of surfactants, critical micelle concentrations, micellar solubilization, and catalysis. Detergency and wetting phenomena. Emulsion technology and applications. D. Blankschtein

10.551 Systems Engineering
Prereq: 10.213, 10.302, 10.37
G (Spring)
3-0-6 H-LEVEL Grad Credit
Introduction to the elements of systems engineering. Special attention devoted to those tools that help students structure and solve complex problems. Illustrative examples drawn from a broad variety of chemical engineering topics, including product development and design, process development and design, experimental
10.579 Applications of Technology in Energy and the Environment
Engineering School-Wide Elective Subject
(Offered under: 1.149, 2.63, 5.00, 10.579, 22.813, ESD.174)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.813.
J. Deutch, R. Lester

10.580 Solid-State Surface Science
Prereq: 10.213
G (Fall)
3-0-6 H-LEVEL Grad Credit
Structural, chemical, and electronic properties of solids and solid surfaces. Analytical tools used to characterize surfaces including Auger and photoelectron spectroscopies and electron diffraction techniques. Surface thermodynamics and kinetics including adsorption-desorption, catalytic properties, and sputtering processes. Applications to microelectronics, optical materials, and catalysis.
K. K. Gleason

10.581J Advanced Materials Processing
(Same subject as 3.52J)
(Subject meets with 3.048)
Prereq: 3.022, 3.044
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 3.52J.
C. Schuh, M. C. Flemings

10.583 Particles and Particulate Processing
Prereq: Permission of instructor
G (Spring)
3-0-6
Can be repeated for credit
Taught jointly with Cambridge University, UK.
T. A. Hatton, J. Bridgewater
10.584] Materials and Processes for Microelectromechanical Devices and Systems
(Same subject as 2.373J, 3.48J, 6.778J, 16.288J)
Prereq: 6.152J/3.155J; permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 3.48J.

L. Anand, K. F. Jensen, M. A. Schmidt,
C. V. Thompson, B. L. Wardle

10.585 Engineering Nanotechnology
Prereq: 10.302, 10.213, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Review of fundamental concepts of energy, mass and electron transport in materials confined or geometrically patterned at the nanoscale, where departures from classical laws are dominant. Specific applications to contemporary engineering challenges are discussed including problems in energy, biology, medicine, electronics, and material design.
M. Strano

10.591 Case Studies in Bioengineering
Prereq: Biology (GIR) or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Analysis and discussion of recent research in areas of bioengineering, including drug delivery, protein and tissue engineering, physiological transport, stem cell technology, and quantitative immunology by senior investigators in the Boston area. Students will read and critique papers, then have discussions with authors about their work.
C. K. Colton

10.595 Molecular Design and Bioprocess Development of Immunotherapies
(Subject meets with 10.495)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 10.495.
J. C. Love

10.625] Electrochemical Energy Conversion and Storage: Fundamentals, Materials and Applications
(Same subject as 2.625J)
Prereq: 3.53, 2.005, 3.046, 10.40, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 2.625J.
Y. Shao-Horn

10.626 Electrochemical Energy Systems (New)
Prereq: 10.50, 18.354, or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
Physical principles of electrochemical energy conversion and storage. Mathematical modeling of transport phenomena, diffuse charge, Faradaic reactions, statistical thermodynamics, and phase transformations. Applications to rechargeable batteries, fuel cells, supercapacitors, solar cells, desalination, and electrokinetic energy conversion.
M. Z. Bazant

10.631 Structural Theories of Polymer Fluid Mechanics
Prereq: 10.301
G (Spring)
3-0-6 H-LEVEL Grad Credit
R. C. Armstrong

10.65 Chemical Reactor Engineering
Prereq: 10.37 or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
Fundamentals of chemically reacting systems with emphasis on synthesis of chemical kinetics and transport phenomena. Topics include kinetics of gas, liquid, and surface reactions; quantum chemistry; transition state theory; surface adsorption, diffusion, and desorption processes; mechanism and kinetics of biological processes; mechanism formulation and sensitivity analysis. Reactor topics include nonideal flow reactors, residence time distribution and dispersion models; multiphase reaction systems; nonlinear reactor phenomena. Examples are drawn from different applications, including heterogeneous catalysis, polymerization, combustion, biochemical systems, and materials processing. Summer 2008 class limited to SMA students only.
M. Strano

10.652] Kinetics of Chemical Reactions
(Same subject as 5.68J)
Prereq: 5.62, 10.37, or 10.65
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 5.68J.
W. H. Green

10.668] Statistical Mechanics of Polymers
(Same subject as 3.941J)
Prereq: 10.568 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Concepts of statistical mechanics and thermodynamics applied to macromolecules: polymer conformations in melts, solutions, and gels; Rotational Isomeric State theory, Markov processes and molecular simulation methods applied to polymers; incompatibility and segregation in incompressible and compressible systems; molecular theory of viscoelasticity; relation to scattering and experimental measurements.
G. C. Rutledge, P. S. Doyle

10.675] Computational Quantum Mechanics of Molecular and Extended Systems
(Same subject as 5.675J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
The theoretical frameworks of Hartree-Fock theory and density functional theory are presented as approximate methods to solve the many-electron problem. A variety of ways to incorporate electron correlation are discussed. The application of these techniques to calculate the reactivity and spectroscopic properties of chemical systems, in addition to the thermodynamics and kinetics of chemical processes, is emphasized. Focus on cutting edge methods to sample complex hypersurfaces, for reactions in liquids, catalysts and biological systems. Students run computations both on Athena and on multi-processor supercomputers.
B. L. Trout
10.702 Introduction to Experimental Biology and Communication
(Subject meets with 7.02)
Prereq: Biology (GIR)
U (Fall, Spring)
4-8-6 Institute LAB
An introduction to the experimental concepts and methods of molecular biology, biochemistry, and genetic analysis. Emphasis on experimental design, critical data analysis, and the development of written communications skills. Twelve units may be applied to the General Institute Laboratory Requirement. Enrollment limited.
D. Kim, T. Schwartz

10.74J Radiative Transfer
(Same subject as 2.58J)
Prereq: 2.51, 10.302, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.58J.
G. Chen

10.792J Proseminar in Manufacturing
(Subject as 2.890, 3.80, 15.792J, 16.985J)
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
See description under subject 15.792J.
D. B. Rosenfield

10.805 Technology, Law, and the Working Environment
(Same subject as ESD.136J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Addresses relationship between technology-related problems and the law applicable to work environment. National Labor Relations Act, Occupational Safety and Health Act, Toxic Substances Control Act, state worker’s compensation, and suits by workers in the courts discussed. Problems related to occupational health and safety, collective bargaining as a mechanism for altering technology in the workplace, job alienation, productivity, and the organization of work addressed. Prior courses or experience in the environmental, public health, or law-related areas.
N. A. Ashford, C. C. Caldart

10.806 Management in Engineering
Engineering School-Wide Elective Subject
(Offered under: 2.96, 6.930, 10.806, 16.653)
Prereq: None
U (Fall)
3-1-8
See description under subject 2.96.
H. S. Marcus

10.807 Innovation Teams
(Same subject as 15.371J)
Prereq: Permission of instructor
G (Fall, Spring)
4-4-4
Students work in teams to develop commercialization strategies for innovative research projects generated in MIT laboratories. Projects cover critical aspects of commercialization, from selecting the target application and market for the technology to developing an intellectual property strategy and performing a competitive analysis. Instruction provided in communication and teamwork skills, as well as analysis of the challenges and benefits of technology transfer. Includes lectures, guest speakers, and extensive team coaching. Designed primarily for students in engineering, science, and management. Applications, resumes, and a brief statement of interest are required prior to registration.
F. Murray, L. Perez-Breva

10.816 Engineering Risk-Benefit Analysis
Engineering School-Wide Elective Subject
(Offered under: 1.155, 2.963, 3.577, 6.938, 10.816, 16.862, 22.82, ESD.72)
Prereq: Calculus II (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.72.
G. E. Apostolakis

10.910 Independent Research Problem
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
For special and graduate students who wish to carry out some minor investigation in a particular field. Subject and hours to fit individual requirements.
W. M. Deen

10.911 Independent Research Problem
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
For undergraduates who wish to do a special investigation or special topic in a particular field. Topic and hours arranged.
B. S. Johnston

10.81 (10.83, 10.85, 10.87) School of Chemical Engineering Practice—Communication Skills and Human Relations
Prereq: Permission of instructor, 10.80
G (Fall, Spring, Summer)
0-6-0 H-LEVEL Grad Credit
Conducted at industrial field stations of the School of Chemical Engineering Practice. Group problem assignments include process development, design, simulation and control, technical service, and new-product development. Grading based on communication skills and human relations in group assignments. Credit granted in lieu of master’s thesis; see departmental description on School of Chemical Engineering Practice for details. Enrollment limited and subject to plant availability.
T. A. Hatton
10.94 Special Problems in Chemical Engineering
Prereq: Permission of instructor
U (Fall)
Units arranged
Can be repeated for credit
Problem of current interest, varying from year to year.
Staff

10.95 Special Problems in Chemical Engineering
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Directed research and study of special chemical engineering problems.
W. M. Deen

10.96 Special Topics in Chemical-Biological Engineering
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Directed research and study of special chemical-biological engineering problems.
W. M. Deen

10.960J Student Seminar in Polymer Science and Technology
(Same subject as 3.903J)
Prereq: None
G (Fall, Spring)
2-0-0 [P/D/F]
Can be repeated for credit
A series of seminars covering a broad spectrum of topics in polymer science and engineering, featuring both on- and off-campus speakers.
G. H. McKinley, P. S. Doyle, K. Van Vliet, D. Irvine

10.961 Seminar in Advanced Air Pollution Research
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Research seminars, presented by students engaged in thesis work in the field of air pollution. Particular emphasis given to atmospheric chemistry, mathematical modeling, and policy analysis.
G. J. McRae

10.962 Seminar in Molecular Cell Engineering
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Weekly seminar with discussion of ongoing research and relevant literature by graduate students, postdoctoral fellows, and visiting scientists on issues at the interface of chemical engineering with molecular cell biology. Emphasis is on quantitative aspects of physicochemical mechanisms involved in receptor/ligand interactions, receptor signal transduction processes, receptor-mediated cell behavioral responses, and applications of these in biotechnology and medicine.
D. A. Lauffenburger

10.963 Research, Technology and Business Development in the Chemical Processing Industries
Prereq: None
G (Spring)
2-0-4 [P/D/F]
Structure of CPI; mission, structure and management of R&D organizations; basic research-technology platforms-business creation; measuring R&D effectiveness; road-mapping: linking business and R&D strategies and plans; integrating R&D with marketing: the product-centered companies; IP strategies and portfolio of R&D projects; stage-gate processes: planning, implementing, monitoring, assessing, and controlling R&D projects; Six-Sigma for Research: R&D proposals and projects; the engineering approach to the execution of R&D projects; R&D and the globalization of CPI; creating and leveraging knowledge-assets; from discovery to the creation of business value; R&D in various segments of the CPI.
Geo. Stephanopoulos

10.969 Molecular Engineering Seminar
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Seminar allows students to present their research to other students and staff. Research topics include molecular simulations techniques and applications, and molecular engineering of pharmaceutical and biopharmaceutical processes and formulations.
B. L. Trout

10.970 Seminar in Molecular Computation
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Seminar allows students to present their research to other students and staff. The research topics include computational chemistry techniques, kinetics, and catalysis. Focus is on molecular-level understanding of chemical change.
W. H. Green

10.971 Seminar in Fluid Mechanics and Transport Phenomena
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Seminar series on current research on Newtonian and non-Newtonian fluid mechanics and transport phenomena, and applications to materials processing. Seminars given by guest speakers and research students.
R. C. Armstrong, G. H. McKinley, P. S. Doyle

10.972 Biochemical Engineering Research Seminar
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Seminar allows students to present their research programs to other students and staff. The research topics include fermentation and enzyme technology, mammalian and animal cell cultivation, and biological product separation.
D. I. C. Wang, C. L. Cooney

10.973 Bioengineering
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Seminar covering topics related to current research in the application of chemical engineering principles to biomedical science and biotechnology.
C. K. Colton, W. M. Deen, J. C. Love
10.974 Seminar in Chemical Engineering Nanotechnology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Seminar covering topics related to current research in the application of chemical engineering principles to nanotechnology. Enrollment limited to 30.
M. S. Strano

10.975 Seminar in Polymer Science and Engineering
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Research seminars, presented by students engaged in thesis work in the field of polymers and by visiting lecturers from industry and academia.
R. E. Cohen, P. T. Hammond, G. C. Rutledge

10.976 Process Design, Operations, and Control
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Seminars on the state of the art in design, operations, and control of processing systems, with emphasis on computer-based tools. Discussions guided by the research interests of participating students. Topics include mathematical and numerical techniques, representational methodologies, and software development.
P. L. Barton

10.98 Special Topics in Chemical Engineering
Prereq: None
G (Spring)
2-1-6 [P/D/F]
Intended for students interested in building, running, and/or growing an organization. Includes lectures and case examples from current startups in the life sciences as well as energy and IT sectors. Covers a broad range of topics such as opportunity assessment, the value proposition, the entrepreneur, legal issues, entrepreneurial ethics, the business plan, the founding team, seeking customers and raising funds. Working in teams, students apply these methods and concepts to write a full business plan which they present to invited venture capitalists. Enrollment limited to 80; 20 students from Course 10.
N. Afeyan

10.981 Seminar in Colloid and Interface Science
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Review of current topics in colloid and interface science. Topics include statistical mechanics and thermodynamics of micellar solutions, self-assembling systems, and microemulsions; solubilization of simple ions, amino acids, and proteins in reverse micelles; enzymatic reactions in reverse micelles; phase equilibria in colloidal systems; interfacial phenomena in colloidal systems; biomedical aspects of colloidal systems.
D. Blankschtein

10.982 Seminar in Experimental Colloid and Surface Chemistry
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
In-depth discussion of fundamental physical relationships underlying techniques commonly used in the study of colloids and surfaces with a focus on recent advances and experimental applications. Topics have included the application of steady-state and time-resolved fluorescence spectroscopies, infrared spectroscopy, and scanning probe microscopies.
T. A. Hatton

10.983 Reactive Processing and Microfabricated Chemical Systems
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Advanced topics in synthesis of materials through processes involving transport phenomena and chemical reactions. Chemical vapor deposition, modeling, and experimental approaches to kinetics of gas phase and surface reactions, transport phenomena in complex systems, materials synthesis, and materials characterization. Design fabrication and applications of microfabricated chemical systems. Seminars by graduate students, postdoctoral associates, participating faculty, and visiting lecturers.
K. F. Jensen

10.984 Biomedical Applications of Chemical Engineering
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Weekly seminar with lectures on current research by graduate students, postdoctoral fellows, and visiting scientists on topics related to biomedical applications of chemical engineering. Specific topics include polymeric controlled release technology, extracorporeal reactor design, biomedical polymers, bioengineering aspects of pharmaceuticals, and biomaterials/tissue and cell interactions.
R. S. Langer

10.987 Solid Thin Films and Interfaces
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Current research topics and fundamental issues relating to the deposition and properties of solid thin films and interfaces. Emphasis on applying analytical techniques, such as solid-state NMR, to explore the thermodynamics and kinetics of growth, defect formation, and structural modification incurred during film growth and post processing.
K. K. Gleason

10.989 Special Topics in Biotechnology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Research seminars, presented by graduate students and visitors from industry and academia, covering a broad range of topics of current interest in biotechnology. Discussion focuses on generic questions with potential biotechnological applications and the quest for solutions through a coordinated interdisciplinary approach.
Gr. Stephanopoulos

10.990 Introduction to Chemical Engineering Research
Prereq: None
G (Fall)
3-0-3 [P/D/F]
Introduction to research in chemical engineering by faculty of chemical engineering department. Focus is on recent developments and research projects available to new graduate students.
K. F. Jensen, W. M. Deen
10.991 Seminar in Chemical Engineering
Prereq: Permission of instructor
G (Fall) 2-0-4 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

10.992 Seminar in Chemical Engineering
Prereq: Permission of instructor
G (Spring) 2-0-4 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
For students working on doctoral theses.
K. F. Jensen

10.994 Molecular Bioengineering
Prereq: Permission of instructor
G (Fall, Spring) 2-0-4 [P/D/F]
Can be repeated for credit
Presentations and discussion by graduate students, postdoctoral fellows, and visiting scientists of current literature and research on the engineering of protein biopharmaceuticals. Topics include combinatorial library construction and screening strategies, antibody engineering, gene therapy, cytokine engineering, and immunotherapy engineering strategies.
K. D. Wittrup

10.995 Cellular and Metabolic Engineering
Prereq: Permission of instructor
G (Fall, Spring) 2-0-4 [P/D/F]
Can be repeated for credit
Graduate students, postdoctoral fellows, visiting scientists, and guest industrial practitioners to present their own research and highlight important advances from the literature in biochemical and bioprocess engineering. Topics of interest include metabolic engineering, novel microbial pathway design and optimization, synthetic biology, and applications of molecular biology to bioprocess development.
K. J. Prather, N. Maheshri

10.996 Seminar in Cellular Engineering
Prereq: Permission of instructor
G (Fall, Spring) 2-0-4 [P/D/F]
Presentations and discussion by graduate students, postdoctoral fellows and visiting scientists on current literature and topics in the field of cellular engineering. Topics include the modeling and experimental validation of cell signaling and transcriptional regulation processes, the evolution of such processes, and engineering these processes in single cells for bioprocess applications.
N. Maheshri

10.997 Theoretical and Computational Immunology Seminar
Prereq: Permission of instructor
G (Fall, Spring) 2-0-4 [P/D/F]
Can be repeated for credit
Presentations and discussions of current literature and research in theoretical and computational immunology. Topics include T cell biology, cell-cell recognition in immunology, polymers and membranes, and statistical mechanics.
A. K. Chakraborty

10.CME Study at Cambridge University
Prereq: None
U (Fall, Spring) Units arranged
Can be repeated for credit
Provides credit for students studying at Cambridge University under the Cambridge-MIT Exchange program. Credit may be used to satisfy specific SB degree requirements by arrangement with the department.
B. S. Johnston

10.EPE UPOP Summer Practice Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 10.EPE, 16.EPE, 22.EPE)
Prereq: 2.EPW or permission of instructor
U (Fall, Spring) 0-1-0 [P/D/F]
Can be repeated for credit
See description under subject 2.EPW.
S. Luperfoy

10.EPR UPOP Reflective Learning Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPR, 2.EPR, 3.EPR, 6.EPR, 10.EPR, 16.EPR, 22.EPR)
Prereq: 2.EPE or permission of instructor
U (Fall) 0-0-3 [P/D/F]
Can be repeated for credit
See description under subject 2.EPR.
S. Luperfoy

10.EPW UPOP IAP Workshop
Engineering School-Wide Elective Subject
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW)
Prereq: None
U (IAP) 3-0-0 [P/D/F]
Can be repeated for credit
See description under subject 2.EPW.
S. Luperfoy

10.ThG Graduate Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer) Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research leading to the writing of an SM, PhD, or ScD thesis; to be arranged by the student and appropriate MIT faculty member.
W. M. Deen

10.ThU Undergraduate Thesis
Prereq: None
U (Fall, Spring, Summer) Units arranged
Can be repeated for credit
Program of research leading to writing an SB thesis; topic arranged between student and MIT faculty member.
B. S. Johnston

10.URG Undergraduate Research
Prereq: None
U (Fall, Spring) Units arranged [P/D/F]
Can be repeated for credit
Opportunity for participation in a research group, or for special investigation in a particular field. Topic and hours to fit individual requirements.
B. S. Johnston

10.URG Undergraduate Research
Prereq: None
U (Fall, Spring) Units arranged
Can be repeated for credit
Bachelor of Science in Chemical Engineering/Course 10

General Institute Requirements (GIRs)  
Science Requirement  
Humanities, Arts, and Social Sciences Requirement  
Restricted Electives in Science and Technology (REST) Requirement [can be satisfied from among 5.12; 5.07 or 7.05; 5.60; 10.301; and 18.03 or 18.034 in the Departmental Program]  
Laboratory Requirement [can be satisfied by 5.310]  
Total GIR Subjects Required for SB Degree  

Communication Requirement  
The program includes a Communication Requirement of 4 subjects:  
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and  
2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program  
Subject names below are followed by credit units, and by prerequisites if any (corequisites in italics)

Required Subjects  
5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)  
5.07 Biological Chemistry I, 12, REST; 5.12  
or  
7.05 General Biochemistry, 12, REST; 5.12, Biology (GIR); or permission of instructor  
5.310 Laboratory Chemistry, 12, LAB; 5.12  
5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)  
10.10 Introduction to Chemical Engineering, 12; Physics I (GIR), Calculus I (GIR), Chemistry (GIR)  
10.213 Chemical and Biological Engineering Thermodynamics, 12; 5.60, 10.10  
One of the following three subjects:  
10.26 Chemical Engineering Projects Laboratory, 15, CI-M; 5.310, 7.02, or 10.702; 10.302  
10.28 Chemical-Biological Engineering Lab, 15, CI-M; 5.310, 7.02, or 10.702; 7.05 or 5.07; or permission of instructor  
10.29 Biological Engineering Projects Laboratory, 15, CI-M; 5.310, 7.02, or 10.702; 10.302  
plus  
10.301 Fluid Mechanics, 12, REST; 18.03, 10.10  
10.302 Transport Processes, 12; 10.301*  
10.32 Separation Processes, 6; 10.213, 10.302  
10.37 Chemical Kinetics and Reactor Design, 9; 5.60, 10.301  
10.490 Integrated Chemical Engineering I, 8; 10.37  
10.491 Integrated Chemical Engineering II, 8; 10.490  
Two of the following three subjects:  
10.492 Integrated Chemical Engineering Topics I, 4; 10.490*  
10.493 Integrated Chemical Engineering Topics II, 4; 10.490*  
10.494 Integrated Chemical Engineering Topics III, 4; 10.490*  
18.03 Differential Equations, 12, REST; Calculus II (GIR)  
or  
18.034 Differential Equations, 12, REST; Calculus II (GIR)  

Restricted Electives  
One subject in Chemical Engineering, except 10.UR, 10.URG, 10.ThU, 10.04, 10.792J, 10.801-10.816, 10.90-10.999  
plus one laboratory subject from the following list:  
3.014 Materials Laboratory, 12, LAB, CI-M  
3.155/6.152J Micro/Nano Processing Technology, 12, CI-M; permission of the instructor  
5.36 Biochemistry and Organic Laboratory, 12, CI-M  
—Module 4 Expression and Purification of Enzyme Mutants, 4; 5.07 or 7.05; Module 2 or 5.310; Module 5  
—Module 5 Kinetics of Enzyme Inhibition, 4; 5.07 or 7.05; Module 2 or 5.310; Module 4  
—Module 6 Organic Structure Determination, 4; 5.12; Module 2 or 5.310; 5.13  
7.02 Introduction to Experimental Biology and Communication, 18, CI-M, LAB; Biology (GIR)  
10.467 Polymer Science Laboratory, 15, CI-M; 5.12, 5.310  
10.26 Chemical Engineering Projects Laboratory, 15, CI-M; 5.310, 7.02, or 10.702; 10.302  
10.28 Chemical-Biological Engineering Lab, 15, CI-M; 5.310, 7.02, or 10.702; 7.05 or 5.07; or permission of instructor  
10.29 Biological Engineering Projects Laboratory, 15, CI-M; 5.310, 7.02, or 10.702; 10.302  
10.702 Introductory Experimental Biology and Communication, 18, CI-M, LAB; Biology (GIR)
### Departmental Program Units That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Unit Type</th>
<th>Required Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Departmental Program Units</td>
<td>36</td>
</tr>
<tr>
<td>Unrestricted Electives</td>
<td>48</td>
</tr>
</tbody>
</table>

| Total Units Beyond the GIRs Required for SB Degree | 198 |

No subject can be counted both as part of the 17-subject GIRs and as part of the 198 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

### Notes

* Alternate prerequisites are listed in the subject description.

** Either 10.26, 10.28, or 10.29 must be taken as a Departmental Requirement and cannot also be used to satisfy this Restricted Laboratory Requirement. **

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
# Bachelor of Science in Chemical-Biological Engineering/Course 10-B

**General Institute Requirements (GIRs)**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
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</table>

**Total GIR Subjects Required for SB Degree**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

**Communication Requirement**

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**

Subject names below are followed by credit units, and by prerequisites if any (corequisites in italics)

**Required Subjects**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.12</td>
<td>12, REST; Chemistry (GIR)</td>
</tr>
<tr>
<td>5.60</td>
<td>Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)</td>
</tr>
<tr>
<td>7.02</td>
<td>Introduction to Experimental Biology and Communication, 18, CI-M, LAB; Biology (GIR) or 10.702 Introduction to Experimental Biology and Communication, 18, CI-M, LAB; Biology (GIR)</td>
</tr>
<tr>
<td>7.03</td>
<td>Genetics, 12, REST; Biology (GIR)</td>
</tr>
<tr>
<td>7.05</td>
<td>General Biochemistry, 12, REST; 5.12, Biology (GIR); or permission of instructor or 5.07 Biological Chemistry I, 12, REST; 5.12</td>
</tr>
<tr>
<td>7.06</td>
<td>Cell Biology, 12; 7.03; 7.05*</td>
</tr>
<tr>
<td>10.10</td>
<td>Introduction to Chemical Engineering, 12; Physics I (GIR), Calculus I (GIR), Chemistry (GIR)</td>
</tr>
<tr>
<td>10.213</td>
<td>Chemical and Biological Engineering Thermodynamics, 12; 5.60, 10.10</td>
</tr>
<tr>
<td>10.28</td>
<td>Chemical-Biological Engineering Laboratory, 15, CI-M; 5.310, 7.02, or 10.702; 7.05 or 5.07; or permission of instructor or 10.29 Biological Engineering Projects Laboratory, 15, CI-M; 5.310, 7.02, or 10.702; 10.302</td>
</tr>
<tr>
<td>10.301</td>
<td>Fluid Mechanics, 12, REST; 18.03, 10.10</td>
</tr>
<tr>
<td>10.302</td>
<td>Transport Processes, 12; 10.301*</td>
</tr>
<tr>
<td>plus</td>
<td></td>
</tr>
<tr>
<td>10.37</td>
<td>Chemical Kinetics and Reactor Design, 9; 5.60, 10.301</td>
</tr>
<tr>
<td>10.499</td>
<td>Integrated Chemical Engineering I, 8; 10.37</td>
</tr>
<tr>
<td>10.491</td>
<td>Integrated Chemical Engineering II, 8; 10.490</td>
</tr>
<tr>
<td>plus two of the following three subjects:</td>
<td></td>
</tr>
<tr>
<td>10.492</td>
<td>Integrated Chemical Engineering III, 4; 10.490*</td>
</tr>
<tr>
<td>10.493</td>
<td>Integrated Chemical Engineering IV, 4; 10.490*</td>
</tr>
<tr>
<td>10.494</td>
<td>Integrated Chemical Engineering V, 4; 10.490*</td>
</tr>
<tr>
<td>18.03</td>
<td>Differential Equations, 12, REST; Calculus II (GIR) or 18.034 Differential Equations, 12, REST; Calculus II (GIR)</td>
</tr>
</tbody>
</table>

**Departmental Program units that also satisfy the GIRs**

(36)

**Unrestricted Electives**

(48)

**Total Units Beyond the GIRs Required for SB Degree**

198

No subject can be counted both as part of the 17-subject GIRs and as part of the 48 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

**Notes**

*Alternate prerequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
UNDERGRADUATE SUBJECTS

Introductory Subjects

11.001J Introduction to Urban Design and Development
(Same subject as 4.250J)
Prereq: None
U (Spring)
3-0-9 HASS
Examines the evolving structure of cities and the way that cities, suburbs, and metropolitan areas can be designed and developed. Boston and other American cities studied to see how physical, social, political and economic forces interact to shape and reshape cities over time.
S. Silberberg-Robinson

11.002J Making Public Policy
(Same subject as 17.30J)
Prereq: None
U (Fall)
4-0-8 HASS-D, Category 4, CI-H
Examines how the struggle among competing advocates shapes the outputs of government. Considers how conditions become problems for government to solve, why some political arguments are more persuasive than others, why some policy tools are preferred over others, and whether policies achieve their goals. Investigates the interactions among elected officials, think tanks, interest groups, the media, and the public in controversies over global warming, urban sprawl, Social Security, health care, education, and other issues.
J. Layzer, A. Campbell

11.003J Methods of Policy Analysis
(Same subject as 17.303J)
Prereq: 11.002J, 17.30J, Coreq: 14.01
U (Spring)
3-0-9 HASS
Provides students with an introduction to public policy analysis. Examines various approaches to policy analysis by considering the concepts, tools, and methods used in economics, political science, and other disciplines. Students apply and critique these approaches through case studies of current public policy problems.
Staff

11.004J CityScope
(Same subject as 4.001J)
Prereq: None
U (Spring)
3-0-9 HASS
See description under subject 4.001J.
J. Fernandez, P. Thompson

11.005 Introduction to International Development
Prereq: None
U (Spring)
3-0-9 HASS
Introduction to ideas and institutions in international development using a quantitative approach. Explores why some poor countries are able to develop faster than others. Topics include planning challenges and models, foreign constraints on policy rights, stakeholders, and building sustainability into planning.
A. Amsden

11.011 The Art and Science of Negotiation
Prereq: None
U (Spring)
3-0-9 HASS
An introduction to bargaining and negotiation in public, business, and legal settings. Combines a “hands-on” skill-building orientation with a look at pertinent social theory. Strategy, communications, ethics, and institutional influences are examined as they influence the ability of actors to analyze problems, negotiate agreements, and resolve disputes in social, organizational, and political circumstances characterized by interdependent interests.
L. Susskind

11.012J The Ancient City
(Same subject as 21H.405J)
Prereq: None
U (Fall)
3-0-9 HASS
See description under subject 21H.405J.
W. Broadhead

11.013J American Urban History I
(Same subject as 21H.231J)
Prereq: None
U (Spring)
2-0-7 HASS
Seminar on the history of institutions and institutional change in American cities from roughly 1850 to the present. Among the institutions to be looked at are political machines, police departments, courts, schools, prisons, public authorities, and universities. Focuses on readings and discussions.
R. M. Fogelson

11.014J American Urban History II
(Same subject as 21H.232J)
Prereq: None
U (Fall)
2-0-7 HASS
Seminar on the history of selected features of the physical environment of urban America. Among the features considered are parks, cemeteries, tenements, suburbs, zoos, skyscrapers, department stores, supermarkets, and amusement parks. Focuses on readings and discussions.
R. M. Fogelson

11.015J Riots, Strikes, and Conspiracies in American History
(Same subject as 21H.104J)
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 5, CI-H
See description under subject 21H.104J.
P. Maier, R. M. Fogelson

11.016J The Once and Future City
(Same subject as 4.211J)
Prereq: None
U (Spring)
3-0-9 HASS, CI-H
Examines the evolving structure of cities, the dynamic processes that shape them, and the significance of a city’s history for its future development. Develops the ability to read urban form as an interplay of natural processes and human purposes over time. Field assignments in
Boston provide the opportunity to use, develop, and refine these concepts. Enrollment limited.

11.091J Migration and Immigration in US History
(Same subject as 21H.221J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
See description under subject 21H.221J.
C. Caldart

11.020 Poverty, Public Policy, and Controversy
Prereq: None
U (Fall)
3-0-9 HASS
Introductory subject to the study of poverty, a persistent controversial issue in the United States, viewed from an international perspective. Focus on how society should respond to poverty, race, and the related issues of the politics of welfare, out-of-wedlock births, homelessness, crime, and drugs. Investigates how particular research findings are brought to controversies. Examines knowledge about poverty and community empowerment from social science research, and how this knowledge is incorporated into public discourse and politics. Experience of other countries is introduced to make explicit the assumptions on which American approaches to poverty are based. Consult Department Headquarters

11.021J Environmental Law, Policy, and Economics: Pollution Prevention and Control
(Same subject as 1.801J, 17.393J)
(Subject meets with 1.811J, 11.630J, ESD.133J)
Prereq: None
U (Fall)
3-0-9 HASS
See description under subject 1.801J.
N. Ashford, C. Caldart

11.022J Regulation of Chemicals, Radiation, and Biotechnology
(Same subject as 1.802J)
(Subject meets with 1.812J, 11.631J, ESD.134J)
Prereq: None
U (Spring)
3-0-9
See description under subject 1.802J.
N. Ashford, C. Caldart

11.023 Bridging Cultural and Racial Differences
Prereq: None
U (Fall)
4-0-8 HASS
Explores cultural and racial stereotypes to increase understanding and appreciation of differences. Emphasis on developing techniques for conflict resolution in a more diversified America in the next century. Attention to economic status, residential segregation, education, political participation, and crime through current readings, films/videos, and guest speakers. C. G. Williams

11.024 Great Cities
Prereq: None
U (Spring)
3-0-6 HASS
Seminar that explores the attributes of cities that are described by a variety of sources, including members of the class, as "great cities." Class concerns a variety of criteria that have been, or might be, used to ascribe greatness to cities, such as attractiveness, quality of life, and richness of opportunity, and examines the consistency and/or contradictory evidence in judgments about cities.
J. P. de Monchaux

11.025J D-Lab: Development
(Same subject as SP.721J)
(Subject meets with 11.472)
Prereq: None
U (Fall)
2-0-7 HASS
See description under subject SP.721J.
A. B. Smith, B. Sanyal

11.026J Downtown
(Same subject as 21H.234J)
(Subject meets with 11.339)
Prereq: None
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
2-0-7 HASS
See description under subject 21H.234J.
R. M. Fogelson

11.027 City to City: Comparing, Researching and Writing about Cities
Prereq: None
U (Spring)
3-0-9 HASS
Introduction to research in urban planning. Study a domestic and a foreign city, focussing on a planning issue common to both. Develop a research question; create a research strategy; interview faculty and other field experts; write and present findings to US and international audiences. Students encouraged to visit one of the study cities for research. Enrollment limited to 10.
C. Abbanat

Specialized Subjects

11.122 Society and Environment
Prereq: None
U (Fall)
3-0-9 HASS
Examines environmental policy and planning from a societal perspective, with a focus on the sociopolitical contexts through which individuals and organizations influence environmental decision making. Topics include environmental values, environmental movements and mobilization, environmental justice, risk perception and communication, and collaborative environmental planning.
J. Carmin

11.123 Big Plans and Mega-Urban Landscapes
Prereq: None
U (Spring)
3-0-6 HASS
Explores the physical, ecological, technological, political, economic and cultural implications of big plans and mega-urban landscapes in a global context. Uses local and international case studies (such as Boston’s Central Artery and Rose Kennedy Greenway, the Pontine Marshes in Italy, and Emscher Park in Germany) to understand the process of making major changes to urban landscape and city fabric, and to regional landscape systems. Includes lectures by leading practitioners. Assignments consider planning and design strategies across multiple scales and time frames.
A. Berger

11.124 Introduction to Education: Looking Forward and Looking Back on Education
Prereq: None
U (Fall)
3-0-3 HASS, CI-H
One of two introductory subjects on teaching and learning science and mathematics in a variety of K-12 settings. Topics include education and media, education reform, the history of education, simulations, games, and the digital divide. Students gain practical experience through weekly visits to schools, classroom discussions, selected readings, and activities to develop a critical and broad understanding of
past and current forces that shape the goals and processes of education, and explores the challenges and opportunities of teaching. Students work collaboratively and individually on papers, projects, and in-class presentations.

**E. Klopfer**

**11.125 Introduction to Education: Understanding and Evaluating Education**

Prereq: None
U (Spring)
3-6-3 HASS, CI-H

One of two introductory subjects on teaching and learning science and mathematics in a variety of K-12 settings. Topics include student misconceptions, formative assessment, standards and standardized testing, multiple intelligences, and educational technology. Students gain practical experience through weekly visits to schools, classroom discussions, selected readings, and activities to develop a critical and broad understanding of past and current forces that shape the goals and processes of education, and explores the challenges and opportunities of teaching. Students work collaboratively and individually on papers, projects, and in-class presentations.

**E. Klopfer**

**11.126 Economics of Education**

(Same subject as 14.48)
(Subject meets with 11.249)
Prereq: 14.01
U (Spring)
4-0-8 HASS

Discusses the economic aspects of current issues in education, using both economic theory and econometric and institutional readings. Topics include discussion of basic human capital theory; the growing impact of education on earnings and earnings inequality; statistical issues in determining the true rate of return to education; the labor market for teachers, implications of the impact of computers on the demand for worker skills; the effectiveness of mid-career training for adults workers; the roles of school choice, charter schools, state standards and educational technology in improving K-12 education, and the issue of college financial aid.

**F. Levy**

**11.127 Computer Games and Simulations for Investigation and Education**

(Same subject as CMS.590)
(Subject meets with 11.252, CMS.863)
Prereq: None
U (Spring)
3-6-3

Explores how we learn from computer games and simulations, and delves into the process of building and testing interactive educational media. First, students investigate the design and use of games and simulations in the classroom (including commercial off-the-shelf games), as well as the research and development issues associated with desktop computer-based, mobile, and non-computer based media. Students then develop their own simulations and games, study what and how others learn from them (including field testing of products), and how games and simulations can be implemented in educational settings. All levels of computer experience welcome. Graduate students are expected to complete additional assignments.

**E. Klopfer**

**11.128 Information Technology and the US Labor Market**

(Subject meets with 11.248, 14.49)
Prereq: 14.01
U (Spring)
4-0-8 HASS

See description under subject 11.248.

**F. Levy**

**11.129 Educational Theory and Practice I**

Prereq: None. Coreq: 11.124
U (Fall)
3-0-9

Concentrates on core set of skills and knowledge necessary for teaching in secondary schools. Topics include educational reform, student behavior and motivation, curriculum design, and the teaching profession. Classroom observation is a key component. Assignments include readings from the educational literature, written reflections on classroom observations, and practice teaching and constructing curriculum. First of a three-course sequence necessary to complete the Teacher Education Program.

**R. Gibb**

**11.130 Educational Theory and Practice II**

Prereq: 11.129
U (IAP)
3-0-9

**11.131 Education Theory and Practice III**

Prereq: 11.130
U (Spring)
3-0-9

Concentrates on the theory and psychology associated with student learning. Topics include educational theory, educational psychology, and theories of learning. Assignments include readings from educational literature, written reflections on classroom observations, presentations on class topics, and practice teaching. Student teaching is a key component of 11.130, the second of the three-course sequence necessary to complete the Teacher Education Program; classroom observation is a key component of 11.131, third of the three-course sequence.

**E. Klopfer**

**11.162 Politics of Energy and the Environment (New)**

Prereq: None
U (Spring)
3-0-9

Introduces politics of making local, state, national and international decisions on energy and the environment. Topics include implementing energy efficiency measures, siting nuclear and alternative energy plants, promoting oil and gas development in wilderness, adapting to climate change, handling toxic waste, protecting endangered species, and conserving water. Case studies include Cape Wind, disputes over oil and gas exploration in the Arctic, the response to Hurricane Katrina, and efforts to craft and comply with the Kyoto Protocol. Limited to 35.

**J. Layzer**

**11.163 Law and Society**

(Same subject as 17.249J, 21A.219J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS, CI-H

See description under subject 21A.219J.

**S. Silbey**

**11.164 Human Rights in Theory and Practice**

(Same subject as 17.391J)
(Subject meets with 11.497)
Prereq: Permission of instructor
U (Fall)
3-0-9

See description under subject 11.497

**B. Rajagopal**
11.165 Infrastructure in Crisis: Energy and Security Challenges (New)
(Subject meets with 11.477)
Prereq: 14.01 or permission of instructor
U (Fall)
3-0-9 HASS
Examines efforts in developing and advanced nations and regions to create, finance and regulate infrastructure from a variety of methodological and disciplinary perspectives. Explores how an energy crisis can be an opportunity for making fundamental changes to improve collapsing infrastructure networks. Introduces the challenges to modern society concerning energy security. Reviews the moral hazard aspects of infrastructure and the common arguments for withholding adequate support to the rebuilding of energy systems. Students taking the graduate version complete additional assignments.
K. Polenske

11.166 Law, Social Movements, and Public Policy: Comparative and International Experience
(Subject meets with 11.496)
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS
See description under subject 11.496.
B. Rajagopal

11.167 Economic Development and Technological Capabilities
Prereq: None
U (Fall)
3-0-9 HASS
The economic growth of developing countries requires the acquisition of technological capabilities. In countries at the world technological frontier, such capabilities refer to cutting edge skills to innovate entirely new products. In developing countries, the requisite technological capabilities are broader, and include production engineering, project execution and incremental innovation to make borrowed technology work. Theories of technology acquisition are examined. The empirical evidence is taken from two sets of developing countries; the most advanced (Taiwan, Korea, India, China and Brazil) and the least advanced (Africa and Middle Eastern countries).
A. Amsden

11.168 Enabling an Energy Efficient Society (New)
(Subject meets with 11.379)
Prereq: None
U (Fall)
3-0-9
Examines innovation in public policy, technology and business models that enable massive-scale improvements in energy efficiency. Explores how they help balance energy supply and demand and prevent unmanageable, irreversible climate change. Students apply analytic methods and design tools to assess strategies to enable energy efficiency. Particular focus on opportunities in US homes and buildings created by utility funding models, carbon cap-and-trade, energy-saving building codes, appliance standards, and green community practices. Limited to 25.
H. Michaels

(3-0-9)
Prereq: None
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit
Planned subjects of instruction for use during IAP only.
Staff

Prereq: None
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit
Planned subjects of instruction for use during IAP only.
Staff

11.188 Urban Planning and Social Science Laboratory
Prereq: Permission of instructor
U (Fall)
3-6-3 Institute LAB
Credit cannot also be received for 11.520
An introduction to the research and empirical analysis of urban planning issues using geographic information systems. Extensive hands-on exercises provide experience with various techniques in spatial analysis and querying databases. Includes a small project on an urban planning problem involving the selection of appropriate methods, the use of primary and secondary data, computer-based modeling, and spatial analysis. Requires some computing experience. Content similar to 11.520.
J. Ferreira

11.189 Special Topics in Urban Studies and Planning
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Small, group study under staff supervision. For undergraduates wishing to pursue further study or fieldwork in specialized areas of urban studies or city and regional planning not covered in regular subjects.
Staff

Tutorials, Fieldwork, and Internships

11.UR Undergraduate Research
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

11.URG Undergraduate Research
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit
Undergraduate research opportunities in Urban Studies and Planning. For further information, consult the Departmental Coordinators.
E. Klopfer

11.ThTJ Thesis Research Design Seminar
(3-0-9)
Prereq: None
U (Fall)
3-0-9
Can be repeated for credit
Designed for students writing a thesis in Urban Studies and Planning or Architecture. Develop research topics, review relevant research and scholarship, frame research questions and arguments, choose an appropriate methodology for analysis, and draft introductory and methodology sections.
C. Abbanat

Laboratories

11.188 Urban Planning and Social Science Laboratory
Prereq: Permission of instructor
U (Fall)
3-6-3 Institute LAB
Credit cannot also be received for 11.520
An introduction to the research and empirical analysis of urban planning issues using geographic information systems. Extensive hands-on exercises provide experience with various techniques in spatial analysis and querying databases. Includes a small project on an urban planning problem involving the selection of appropriate methods, the use of primary and secondary data, computer-based modeling,
11.190–11.195 Special Topics in Urban Studies and Planning
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Small, group study under staff supervision. For undergraduates wishing to pursue further study or fieldwork in specialized areas of urban studies or city and regional planning not covered in regular subjects.
Staff

11.196 Urban Fieldwork and Internships
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Practical application of city and regional planning techniques to towns, cities, and regions, including problems of replanning, redevelopment, and renewal of existing communities. Includes internships, under staff supervision, in municipal and state agencies and departments under staff supervision.
Consult M. J. Daly

11.197–11.199 IAP Special Studies in Urban Studies and Planning
Prereq: None
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit
Planned subjects of instruction for use during IAP only.
Staff

11.201 Gateway: Planning Action
Prereq: None
G (Fall)
4-1-7
Introduces the profession of urban and regional planning. Emphasizes the key sensibilities necessary for effective planning practice as well as professional writing and oral communication skills.
B. Sanyal

11.202 Gateway: Planning Economics
Prereq: 11.203
G (Fall)
2-0-2
Introduces applications of microeconomic theory to planning problems including urban form and structure, government’s role in urban settings and problems of housing finance.
F. Levy

11.203 Microeconomics
Prereq: None
G (Fall)
3-0-5
Introduces basic economic analysis for planning students including the functioning of markets, the allocation of scarce resources among competing uses, profit maximizing behavior in different market structures. Course illustrates theory with contemporary economic issues.
F. Levy

11.205 Introduction to Spatial Analysis (New)
Prereq: None
G (Fall; first half of term)
3-0-5
Practical introduction to spatial analysis and geographic information systems (GIS). Examines how geography is represented digitally and how nonrandom distributions of phenomena as diverse as poverty and scenic resources can be better understood by examining their spatial characteristics.
M. Flaxman

11.220 Quantitative Reasoning and Statistical Methods for Planning I
Prereq: Permission of instructor
G (Spring)
4-2-6
Develops logical, empirically based arguments using statistical techniques and analytic methods. Covers elementary statistics, probability, and other types of quantitative reasoning useful for description, estimation, comparison, and explanation. Emphasis on the use and limitations of analytical techniques in planning practice. Restricted to first-year M.C.P. students.
E. Glenn

Department-wide Subjects

Methods

11.221 Quantitative Reasoning and Statistical Methods for Planning II
Prereq: 11.220 or permission of instructor
G (Spring)
3-1-8
Credit cannot also be received for 11.241
Using the analytical skills developed in 11.220, this subject extends the statistical techniques to address topics in modeling and forecasting. Emphasizes the use and limitation of modeling in planning practice. Covers techniques of multiple regression and time series analysis. Uses data sets from actual planning applications for examples and problem sets.
Staff

11.225 Argumentation and Communication
Prereq: None
G (Fall)
2-0-4
Can be repeated for credit
A writing practicum associated with 11.201 that focuses on helping students write and present their ideas in cogent, persuasive arguments and other analytical frameworks. Reading and writing assignments and other exercises stress the connections between clear thinking, critical reading, and effective writing.
C. Abbanat

11.229 Advanced Writing Seminar
Prereq: None
G (Spring)
2-0-7
Can be repeated for credit
Focuses on writing and speaking skills. Students bring their writing from other classes to the workshop to practice reviewing and rewriting skills and make several oral presentations. Different types of writing including proposals, memos, thesis, press releases, and writing sound bites for the media.
C. Abbanat
11.232 The Public Policy Field: History and Dilemmas
Prereq: Permission of instructor
G (Spring)
3-0-9
Examines the evolution and challenges that define the field as an intellectual and practical project of producing change in the world, focused on policy as an instrument for governing. Covers policy design, evaluation, and discourse in the policy research literature, structured around the Oxford Handbook of Public Policy.
Consult M. Rein

11.233 Research Design for Policy Analysis and Planning
Prereq: Permission of instructor
G (Fall)
3-0-9
Develops skills in research design for policy analysis and planning. Emphasizes the logic of the research process and its constituent elements. Topics include philosophy of science, question formulation, hypothesis generation and theory construction, data collection techniques (e.g. experimental, survey, interview), ethical issues in research, and research proposal preparation.
J. Carmin

11.234 Making Sense: Qualitative Methods for Designers and Planners
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
2-4-6
Surveys uses of qualitative methods in environmental design practice and research. Topics include: observing environments and physical traces, observing environmental behavior, asking questions, focused interviews, standardized questionnaires, use of written archival materials, use of visual materials including photographs and maps, case studies, and comparative methods. Emphasizes use of each of these skills to collect and make sense of qualitative data.
L. Vale

11.235 Analyzing Projects and Organizations
Prereq: 11.701 or permission of Instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Analyzes how organizations behave—both government and nongovernment—drawing on the literature of the sociology of organizations, political science, and public administration. Demonstrates rationality in otherwise seemingly chaotic organizational environments and implementation experience. Builds analytic skills for evaluating programs and projects, organizations, and environments. Draws equally on developing-country and developed-country literature.
J. Tendler

11.238 J Ethics of Intervention: Anthropological Approaches
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 21A.790J.
E. C. James

11.239 J Ethics of Intervention: Anthropological Approaches
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 21A.790J.
E. C. James

11.241 Applied Regression Analysis in Urban Planning
Prereq: 11.220 or permission of instructor
G (Spring)
3-1-2
Credit cannot also be received for 11.221
Introduces regression analysis as a quantitative approach to urban planning questions. Develops a basic understanding of the concepts and techniques. Provides opportunity for extensive hands-on exercises. Same content as first half of 11.221.
Staff

11.248 Information Technology and the US Labor Market
(Subject meets with 11.128, 14.49)
Prereq: 14.01
G (Spring)
4-0-8
Combines economic theory, econometric studies, workplace case studies, and pieces of cognitive psychology to examine the impact of computerization on US employment and wages. Topics include: recent trends in wages and employment; the role of computers in demands for particular labor force skill; computers’ impact on the functioning of markets and the economy’s productivity; and the extent to which computers can help teach new skills to children and adults.
F. Levy

11.249 Economics of Education
(Subject meets with 11.126J, 14.48)
Prereq: 14.01
G (Spring)
4-0-8
See description under subject 11.126J.
F. Levy

11.250 J Computer Games and Simulations for Investigation and Education
(Same subject as CMS.863J)
Prereq: None
G (Spring)
3-6-3
See description under subject 11.127.
E. Klopf

11.255 Negotiation and Dispute Resolution in the Public Sector
Prereq: None
G (Fall)
4-0-8
Investigates social conflict and distributional disputes in the public sector. While theoretical aspects of conflict and consensus building are considered, focus is on the practice of negotiation and dispute resolution. Comparisons between unassisted and assisted negotiation are reviewed along with the techniques of facilitation and mediation.
L. Susskind

11.257 Multi-Party Negotiation Seminar: Addressing the Land Claims of Indigenous Peoples
Prereq: 11.255 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-6 H-LEVEL Grad Credit
Focus is on strategies for addressing the land claims of indigenous peoples around the world as well as their demands for autonomy. Taught in conjunction with the MIT Program on Human Rights and Justice.
L. Susskind

Public Policy

11.260 The Comparative Politics of Urban Policy
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Familiarizes students with unresolved political conflicts and social questions plaguing urban policy makers. Main point of entry is power: who has it, who doesn’t, why, and how it affects the character of cities and urban policies. Special attention paid to local government, political parties, social movements, private sector firms, and labor organizations. Policies under examination include those related to housing, transportation, land use, employment, environment, and migra-
tion; case studies include US, European, and Latin American cities.

J. P. Thompson

Program Group Subjects

City Design and Development

11.301J Introduction to Urban Design and Development
(Same subject as 4.252J) Prereq: Permission of instructor
G (Fall) 3-0-9

Examines both the structure of cities and ways they can be changed. Includes historical forces that have produced cities, models of urban analysis, contemporary theories of urban design, implementation strategies. Core lectures supplemented by discussion sessions focusing on student work and field trips. Guest speakers present cases involving current projects illustrating the scope and methods of urban design practice.

D. Frenchman

11.302J Urban Design Politics
(Same subject as 4.253J) Prereq: Permission of instructor
G (Spring) 3-0-6 H-LEVEL Grad Credit

Examines ways urban design contributes to distribution of political power and resources in cities. Investigates the nature of relations between built form and political purposes through close study of a wide variety of situations where public sector design commissions and planning processes have been clearly motivated by political pressures. Lectures and discussions focus on specific case studies of 20th-century government-sponsored designs carried out under diverse regimes in the US, Europe, and elsewhere.

L. Vale

11.303J Real Estate Development Studio: Complex Urban Projects
(Same subject as 4.254J) Prereq: Permission of instructor
G (Spring) 6-0-9 H-LEVEL Grad Credit

Focuses on the process of synthesizing projects for the real estate development industry, including the integration of finance and marketing with physical programming and design. Interdisciplinary student teams analyze how to maximize value in large-scale, mixed use projects and then prepare professional development proposals. Reviews contemporary practice in residential and commercial development, as well as innovative new real estate products, to provide a foundation for project work. Projects are interspersed with lectures, field trips, and short sketch exercises. Integrates skills and knowledge in the MSRED program; also open to other students interested in real estate development.

D. Frenchman, P. Roth

11.304J Site and Urban Systems Planning
(Same subject as 4.255J) Prereq: Permission of instructor
G (Spring) 2-2-8

Land inventory, analysis and the planning of sites and the infrastructure systems which serve them. Spatial organization of uses, parcellization, design of roadways, grading, utility systems, stormwater runoff, parking, traffic and off-site impacts, landscaping. Lectures on analytical techniques and examples of good site-planning practice. Assignments and a client based project.

E. Ben-Joseph

11.305 Landscape Ecology and Urban Development
Prereq: None
G (Spring) 3-0-9 [P/D/F]

Presents a framework for current landscape ecological theory, structured to encourage application in physical planning of landscapes. Case studies link theory to practice, and include both urban and rural landscapes. Science and planning are examined as social practices which rely on situated knowledge. Past and present methods of ecological planning are reviewed and critiqued in a student project. Major topics include biodiversity, cyclical processes, assessment of landscape structures, and design for sustainability.

Staff

11.306 Planning Studio
Prereq: Permission of instructor
G (Spring) 6-0-12 H-LEVEL Grad Credit

Provides experience in tackling city and regional planning problems in real world settings. Students work with local clients to define issues and synthesize approaches to change that enhances performance of the environment and improves the quality of life for users and residents. The focus of the studio changes each year; past problems have involved community develop-

ment in downtown Santiago, Chile, and sustainable residential development in Shanghai.

Staff

11.307 Beijing Urban Design Studio
(Subject meets with 4.166) Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall) 0-18-0 H-LEVEL Grad Credit

Design and development studio that involves architects and planners, working in teams on a contemporary design project of importance in Beijing, China. Students analyze conditions, explore alternatives, and synthesize architecture, city design, and implementation plans. Supplemented by lectures and brief study tours that expose students to history and contemporary issues of urbanism in China. Offered every other summer in residence at Tsinghua University, Beijing, involving students and faculty from both schools. Limited to 10.

D. Frenchman, J. Wampler

11.308J Advanced Seminar: Urban Nature and City Design
(Same subject as 4.213J) Prereq: Permission of instructor
G (Fall) 3-0-9 H-LEVEL Grad Credit

Examines the urban environment as a natural phenomenon, human habitat, medium of expression, and forum for action. Subject has two related, major themes: how ideas of nature influence the way cities are perceived, designed, built, and managed; and how natural processes and urban form interact and the consequences of these for human health safety and welfare. Enrollment limited.

A. Spirn

11.309J Sensing Place: Photographing the Urban Landscape
(Same subject as 4.215J) Prereq: None
G (Fall) 3-0-9

Explores photography as a disciplined way of seeing, or investigating urban landscapes and expressing ideas. Readings, observations, and photographs form the basis of discussions on light, detail, place, poetics, narrative, and how photography can inform design and planning. Enrollment limited.

A. Spirn
11.310] Media Technology and City Design and Development
(Same subject as 4.243J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9
Explores the potential of media technology and the Internet to enhance communication and transform city design and community development in inner-city neighborhoods. Introduces a variety of methods for describing or representing a place and its residents, for simulating actions and changes, for presenting visions of the future, and for engaging multiple actors in the process of envisioning change and guiding action. Working with local clients, students learn tools like digital storytelling to build media rich representations of urban environments.
A. Spirn, C. McDowell

11.311] Ideal Forms of Contemporary Urbanism
(Same subject as 4.262J)
Prereq: 4.645, 4.241J, 11.330J or permission of instructor
G (Fall)
Units arranged H-LEVEL Grad Credit
See description under subject 4.262J.
A. D’Hooghe

11.314] Water, Landscape and Urban Design
(New)
(Same subject as 4.214J)
Prereq: Permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 4.214J.
J. Wescoat

11.316] Landscape and Urban Heritage Conservation (New)
(Same subject as 4.216J)
Prereq: Permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 4.216J.
J. Wescoat

11.328] Urban Design Skills: Observing, Interpreting, and Representing the City
(Same subject as 4.240J)
Prereq: None
G (Fall)
3-0-9
Introduction to the methods of recording, evaluating, and communicating about the urban environment. Through visual observation, field analysis, measurements, interviews, and other means, students learn to draw on their senses and develop their ability to deduce, conclude, question, and test conclusions about how the environment is used and valued. Through the use of representational tools such as drawing, photographing, computer modeling and desktop publishing, students communicate what is observed as well as their impressions and design ideas. Intended as a foundation for future studio work in urban design.
E. Ben-Joseph

11.329] Social Theory and the City
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Explores how social theories of urban life can be related to the city’s architecture and spaces. Classic or foundational writings about the city, addressing such topics as the public realm and public space; impersonality; crowds and density; surveillance and civility; imprinting time on space; spatial justice; and the segregation of difference. Aims to generate new ideas about the city by connecting the social and the physical, using Boston as a visual laboratory. Requires term paper mediating what is read with what has been observed.
R. Sennett

11.330] Theory of City Form
(Same subject as 4.241J)
Prereq: 11.001J, 4.252J, or 11.301J
G (Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 4.241J.
J. Beinart

11.332] Urban Design Studio
(Same subject as 4.163J)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 4.163J.
J. Beinart, M. Dennis, A. D’Hooghe, R. Mehrotra

11.333] Urban Design Seminar
(Same subject as 4.244J)
Prereq: None
G (Spring)
2-0-7
Core lectures and student research focus on defining the future forms and function of the city and directions in urban design. Examines case studies of cutting edge urban design themes and projects, and explores how such efforts may be evaluated. Invited urban design practitioners critique student work on individual topics. Required for Urban Design certificate students.
D. Frenchman

11.334] Advanced Seminar in Landscape & Urbanism
(Same subject as 4.264J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Explores the relationships between landscape and urbanism, and the theories, tactics and workings of the emerging field of landscape urbanism. Conceives of the field as an intellectual realignment of landscape’s role in urbanization processes, rather than qualifying it as a practice-based discipline conditioned by the study of historical precedents and contemporary built projects. Weekly lectures, readings, and guest speakers present a wide array of multi-disciplinary topics. Students conduct independent research which identifies future work for the field. Topics vary from year to year.
A. Berger

11.335] Cities of Tomorrow
(Same subject as 4.245J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Research seminar on the future of urban design, to focus on developing a realistic projection of the organization, function, and form of cities, based on an analysis of contemporary trends. Review of historical efforts in the tradition of predicting urban change. Analysis of contemporary urban design projects and proposals. Supplemented by readings and speakers in par-
allel fields likely to have impact on urban form, including information processing, communications, entertainment.

D. Frenchman

11.336| Asia Modern: Architecture and Urbanism (New)
(Same subject as 4.260J)
Prereq: None
G (Spring)
3-0-9
See description under subject 4.260J.

R. Mehrotra

11.337J Urban Design Policy and Action
(Same subject as 4.247J)
Prereq: 11.301J
G (Spring)
2-0-7 H-LEVEL Grad Credit
Examines the relationship between public policy and urban design through readings, discussions, presentations, and papers. Analyzes the ways in which policies shape cities, and investigates how governments implement urban design. Provides a critical understanding of both the complex system of governance within which urban design occurs and the effective tools available for creative intervention.

A. Inam

11.339 Downtown
(Subject meets with 11.026J, 21H.234J)
Prereq: None
G (Spring)
2-0-7
See description under subject 21H.234.

R. M. Fogelson

11.340J Real Estate Development III: Legal Issues in the Development Process
(Same subject as 15.658J)
Prereq: Permission of instructor
G (Spring; second half of term)
3-0-3 H-LEVEL Grad Credit
Reviews the legal issues that arise in the course of acquiring, managing, and developing real estate. Topics covered include purchase and sale agreements, organization of the ownership entity, financing, contracting, federal income taxation of real estate, fiduciary relationships, leasing, and workouts.

L. Fisher, J. Pennington

11.342J The Impact of Globalization on the Built Environment
(Same subject as 1.463J, ESD.53J)
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit
See description under subject 1.463J.

F. Moavenzadeh, D. Wolff

11.344J Innovative Project Delivery in the Public and Private Sectors
(Same subject as 1.472J)
Prereq: Permission of instructor
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
Examines the compatibility of various project delivery methods, consisting of organizations, contracts, and award methods, with certain types of projects and owners. Six methods examined: traditional general contracting; construction management; multiple primes; design-build; turnkey; and build-operate-transfer. Consists of lectures, case studies, guest speakers, and a team project to analyze a case example.

C. M. Gordon

11.345J Entrepreneurship in Construction and Real Estate Development
(Same subject as 1.462J)
Prereq: Permission of instructor
G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
Explains role of the entrepreneur in the construction industry using case studies to outline different steps in developing construction enterprises. Emphasis on strategic marketing component in the development of these businesses. Lectures address program, development, and construction management services. Guest lectures from entrepreneurs in their field. Team project identifying an opportunity and developing a strategic marketing/business plan for a company in the design/construct or related industries.

J. F. Kennedy

11.346 Housing Markets
Prereq: None
G (Spring; first half of term)
2-0-4
Explores basics of housing economics, including issues of affordability. Introduces hedonic modeling. Focuses on helping students develop a research topic in this area. Students write a term paper on a housing finance topic of their choice.

L. Fisher

11.347 Topics in Housing Finance
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring; second half of term)
2-0-4
Focuses on housing finance in the private sector. Designed for students familiar with basic financial concepts. Topics include the optimality of mortgage terms and covenants, the history and economics of the U.S. housing finance system and current products designed for affordable housing development. Students write a term paper on a housing finance topic of their choice.

L. Fisher

11.349 Real Estate Development I: The Development Process
Prereq: None
G (Fall)
6-0-9
Presents the information, skills and techniques necessary to create the physical products of real estate and manage the process of real estate development in each of the functional areas. Assesses the fundamental characteristics of the real estate industry, its products, contracts, regulatory and legal context, and its markets. Students work in teams to create a development proposal. Restricted to MSRED students.

T. Ciochetti, L. Fisher, Y. Tsipis

11.350 Real Estate Development II: Products and Systems (New)
Prereq: 11.349 or permission of instructor
G (Fall)
2-0-7 H-LEVEL Grad Credit
Provides a concise overview of the range of real estate product types and building systems encountered in professional development practice. Focuses on the relationship among real estate product types, building systems, and the multitude of factors that the professional must consider when evaluating them for a specific project. First course module explores the physical attributes and value drivers associated with residential, office, retail and hotel product types. Second module surveys commercial building systems, from foundations to roofing, and analyzes the factors that lead professionals to select specific systems for specific product types.

Y. Tsipis
Environmental Policy and Planning

11.360 Community Growth and Land Use Planning
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Seminar and fieldwork on strategies of planning and control for growth and land use, chiefly at the municipal level. Growth and its local consequences; land use planning approaches; implementation tools including innovative zoning and regulatory techniques, physical design, and natural systems integration. Projects arranged with small teams serving municipal clients.
T. S. Szold, E. Ben-Joseph

11.361 International Environmental Management Practicum
Prereq: Permission of instructor
G (Spring)
3-6-3 H-LEVEL Grad Credit
Client-driven project that addresses environmental policy and planning issues in an international field setting. Students draw on their coursework and professional experience to address pragmatic environmental issues and concerns of either government agencies or non-governmental organizations in other countries. Location and substantive issue will vary.
EPP Staff

11.362 Environmental Management Practicum
Prereq: Permission of instructor
G (Fall)
3-6-3 H-LEVEL Grad Credit
Focuses on client-driven problems of environmental planning, with a particular emphasis on sustainable energy and integrated resource planning. Students use advanced analytic methods and interact with regulatory agencies, NGOs, corporations, and other stakeholder groups. Student team progress reviewed by a multidisciplinary advisory group. The final deliverable presented to the client for review and comment.
Staff

11.363 Civil Society and the Environment
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Examines the roles civil society actors play in national and international environmental policy and politics. Considers theories pertaining to the development and import of civil society, social movement development and mobilization, and collaboration between state and non-state actors. Case studies of civil society response to specific environmental issues illustrate theoretical issues and assess the impacts that these actors have on domestic, foreign, and international policy and planning outcomes.
J. Carmin

11.365 Disaster, Vulnerability, and Resilience
Prereq: None
G (Spring)
3-0-9
Explores vulnerabilities to natural and technological disasters and ways to promote resilience. Designed both for people interested in the societal dimensions of disaster from a research or policy perspective and for those who may be charged with responsibility for on-the-scene intervention. Topics addressed include social, technological, and environmental vulnerabilities; disaster institutions, agencies and policies; normative and operational issues in preparation, warning, and response; individual and group decision-making under stress.
J. Carmin

11.366 Planning, Participation, and Consensus Building for Sustainable Development
(Same subject as 1.817J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Examines the political economy of development planning and implementation, with a focus on developing countries in Asia, Africa and Latin America. Assesses the concept of sustainable development and its application in planning processes. Asks when and how stakeholder participation, negotiation and consensus building help or hinder attempts to promote sustainability. Emphasis on integration of theory and practice, using local, sectoral, national and global cases.
D. Fairman

11.367 The Law and Politics of Land Use
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Analysis of local and state power to regulate land use and development. Particular emphasis on the evolution of planning and zoning regulations, and the perceived narrowing of the relationship between public improvements requirements and development impact. The ability of regulatory bodies to impose environmental performance standards and limit development activity is explored in relation to recent Supreme Court and State SJC decisions. Development decisions rendered by public agencies are reviewed, critiqued, and discussed.
T. Szold

11.368 Environmental Justice
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Explores the foundations of the environmental justice movement, current and emerging issues, and the application of environmental justice analysis to environmental policy and planning. Examines claims made by diverse groups along with the policy and civil society responses that address perceived inequity and injustice. International issues and perspectives also considered.
J. Carmin

11.369 Energy Policy for a Sustainable Future
(Same subject as 17.398J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Focuses on a wide range of current energy and energy-related environmental policies that foster the development and mass deployment of sustainable energy technologies, fuels, and practices. Primary focus is US-based policies at the state, regional and federal level that impact the electricity, transportation and buildings and facilities sectors. Detailed case studies, diverse readings, and guest lectures by prominent policy makers and practitioners. Limited to 35.
J. D. Raab

11.371 Sustainable Energy
(Same subject as 1.818J, 2.65J, 10.391J, 22.811J, ESD.166J)
(Subject meets with 2.650J, 10.291J, 22.081J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 22.811J.
M. W. Golay, J. P. Freidberg

11.372 Environmental Planning Methods Modules
Prereq: 11.601
G (Fall, IAP, Spring)
Units arranged
Various methods modules cover a range of analytical tools and techniques used by practicing planners and resource management professionals. Modules cover environmental impact assessment, principles of landscape ecology, health risk assessment techniques, cost-benefit analysis techniques, and techniques of envi-
11.373 Science, Politics and Environmental Policy
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Examines the role of science in the U.S. environmental policymaking process. Part I examines the methods by which scientists learn about the natural world; the treatment of science by experts, advocates, the media, and the public; and the way science is used in legislative, administrative and judicial decision making. Part II takes up novel approaches to integrating science into politics, such as ecosystem-based management, stakeholder collaboration, local knowledge, adaptive management, and the precautionary principle. Case studies help students compare theory and practice.
J. Layzer

11.375 Planning for the Impacts of Climate Change—Synthesizing Science and Governance
Prereq: 11.601
G (Spring)
2-0-7
Examines how collaborative adaptive management and adaptive governance helps communities and natural resource managers plan for the impacts of climate change. Students develop and test processes that facilitate learning and collaboration among stakeholders while working to harmonize science, politics, and policy to produce more sustainable natural resource management and resilient communities. Students have the opportunity to present the results of their research to officials of the Department of the Interior.
H. Karl

11.376 Sustainability in Action: Boston
Prereq: Permission of instructor
G (Spring)
3-0-12 H-LEVEL Grad Credit
Project-based course that aims to devise a socially equitable approach to urban environmental sustainability for the city of Boston. Introduces concepts of environmental sustainability, social equity, systems dynamics, ecological footprints, and environmental indicators. Working in teams, students map Boston's environmental and demographic features; identify opportunities to make the city more sustainable; and make a persuasive case for adopting their ideas.
J. Layzer

11.378 Water Reading Group (New)
(Same subject as 4.625J)
Prereq: Permission of instructor
G (Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 4.625J.
J. Wescoat

11.379 Enabling an Energy Efficient Society (New)
(Same subject meets with 11.168)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.168.
H. Michaels

Housing, Community, and Economic Development

11.401 Introduction to Housing and Community Development
Prereq: None
G (Fall)
3-0-9
Explores how public policy and private markets affect housing, economic development, and the local economy; provides an overview of techniques and specified programs policies and strategies that are (and have been) directed at neighborhood development; gives students an opportunity to reflect on their personal sense of the housing and community development process; emphasizes the institutional context within which public and private actions are undertaken.
J. P. Thompson

11.402 Urban Politics: Race and Political Change
Prereq: None
G (Fall)
3-0-9
Examines the place of US cities in political theory and practice. Particular attention given to contemporary issues of racial polarization, demographic change, poverty, sprawl, and globalization. Specific cities are a focus for discussion.
J. P. Thompson

11.403 Springfield Community Studio
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
A practicum subject that focuses on the physical, programmatic, and social renewal of the North End community in Springfield, MA by combining classroom work with an applied class project. Builds on a long-term commitment to partnership with the North End, a predominantly Puerto Rican community with strong social networks, a high level of community involvement, and all the attendant issues of urban poverty. Each year the practicum works on a specific issue identified by the community. Past topics have included economic planning, land use planning, and environmental mapping.
C. McDowell

11.410 Cities and Regions: Urban Economics and Public Policy
(Same subject as 12.283J, 14.573J, ESD.191J)
Prereq: 14.03 or 14.04
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 14.573J.
W. Wheaton

11.414 Labor and Politics
(Same subject as 17.188J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9
See description under subject 17.188J.
R. Locke

11.422 Downtown Management Organizations
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Focuses on the origins, functions, and implications of downtown management organizations (DMOs) such as business improvement districts in a variety of national contexts including the US, Canada, South Africa, and the UK. Critically examines how a range of urban theories provide a rationale for the establishment and design of DMOs; the evolution and transnational transfer of DMO policy; and the spatial and political externalities associated with the local proliferation of DMOs. Particular emphasis given to the role of DMOs in securing public space.
L. Hoyt
11.423 Information, Asset-building, and the Immigrant City
Prereq: Permission of instructor
G (Spring)
4-6-2 H-LEVEL Grad Credit
Practicum follows a participatory action research model whereby students work hand-in-hand with residents and such civic leaders as not-for-profit housing developers and municipal planners to create and implement green affordable housing strategies in Lawrence, MA. As the cornerstone of a sustained partnership between MIT and the people of Lawrence, practicum relies on strong relationships with community partners, including several MIT alumni, to advance new knowledge and practices to transform small, post-industrial cities. Emphasizes use of information technologies for asset-building, network organizing, and reflection.
L. Hoyt, E. Glenn

11.425 Urban Labor Markets
Prereq: 11.203
G (Spring)
3-0-9
Focuses on the recent evolution of central city labor markets. Topics include the changing occupational structure of central cities; the occupation/population skills mismatch; education, wages, and urban schooling; the spatial mismatch and mobility strategies; the position of minority groups in central city labor markets; the interaction between welfare programs and labor markets; the potential role of job training.
Staff

11.426 Cities and Globalization
Prereq: None
G (Fall)
3-0-9
Cities examined in the context of globalization. Subject examines changing nature and character of cities as produced by increased transnational migration flows, accelerated international trade, diminished institutional capacities of states (both local and national), and new forms of urban employment investment, and economic restructuring in an age of globalization. Among themes discussed are globalization’s impact on the economic health, social and ethnic composition, political dynamics, and urban policy priorities of cities. Readings focus mainly on the American urban experience, including Boston, and Detroit, with additional emphasis on “global cities” (New York City, Los Angeles, London, Tokyo, Mexico City, São Paolo), and how transformations in these locales produce increasing urban inequality both nationally and worldwide. Consult Department Headquarters

11.427 Urban Labor Markets and Employment Policy
(Same subject as 15.677J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 15.677J.
P. Osterman

11.430 Leadership in the Real Estate Industry
(Same subject as 15.941J)
Prereq: None
G (Fall)
3-0-6
See description under subject 15.941J.
G. Schuck

11.431 Real Estate Finance and Investment
(Same subject as 15.426J)
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Concepts and techniques for analyzing financial decisions in property development and investment. Topics: leasing and property income streams, pro forma analysis, equity valuation, tax analysis, options, risk, and the financial structuring of real property ownership.
Staff

11.432 Real Estate Capital Markets
(Same subject as 15.427J)
Prereq: 11.431J; 15.401, 15.402, or 15.414
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
D. Geltner

11.433 Real Estate Economics
(Same subject as 15.021J)
Prereq: 14.01, 15.010, or 15.011
G (Fall)
4-0-8 H-LEVEL Grad Credit
Focuses on developing an understanding of the factors that shape and influence markets for real property. Includes demographic analysis, patterns of regional growth, construction cycles, urban location theory, and modeling techniques for predicting demand.
W. C. Wheaton

11.434 Tools for Analysis: Design for Real Estate and Infrastructure Development
(Same subject as 15.428), ESD.712J
Prereq: None
G (Spring; second half of term)
2-0-4
Introduction to analytical tools to support design and decision-making in real estate and infrastructure development. Particular focus on identifying and valuing sources of flexibility using “real options,” Monte-Carlo simulation, and other techniques from the field of engineering systems. Integrates economic and engineering perspectives, and is suitable for students with various backgrounds. Provides useful preparation for thesis work in the area.
D. Geltner, R. de Neufville

11.435 Mixed-Income Housing Development (New)
Prereq: None
G (Fall)
3-0-9
Provides an overview of affordable and mixed-income housing development for students who wish to understand the fundamental issues and requirements of affordable housing, the process of planning, and developing such housing. Students gain practical experience assembling an affordable or mixed-income housing development proposal.
P. Roth

11.437 Financing Economic Development
Prereq: None
G (Fall)
4-0-8
Focuses on financing tools and program models to support local economic development. Overview of private capital markets and financing sources to understand capital market imperfections that constrain economic development, business accounting, financial statement analysis, federal economic development programs, and public finance tools. Policies and program models covered include revolving loan funds, guarantee programs, venture capital funds, bank holding companies, community development loan funds and credit unions, micro enterprise funds, and the Community Reinvestment Act.
K. F. Seidman

11.438 Economic Development Planning
Prereq: 11.203, 11.220
G (Spring)
3-0-9 H-LEVEL Grad Credit
Focuses on the policy tools and planning techniques used to formulate and implement
local economic development strategies. Includes an overview of economic development theory, discussion of major policy areas and practices employed to influence local economic development, a review of analytic tools to assess local economies and how to formulate strategy. Coursework includes formulation of a local economic development strategy for a client.

K. F. Seidman

11.439 Revitalizing Urban Main Streets
Prereq: 11.401 or 11.301J or 11.328J
G (Spring)
4-0-11 H-LEVEL Grad Credit

Workshop explores the integration of economic development and physical planning interventions to revitalize urban commercial districts. Covers: an overview of the causes of urban business district decline, revitalization challenges, and the strategies to address them; the planning tools used to understand and assess urban Main Streets from both physical design and economic development perspectives; and the policies, interventions, and investments used to foster urban commercial revitalization. Students apply the theories, tools and interventions discussed in class to preparing a formal neighborhood commercial revitalization plan for a client business district.

K. F. Seidman, S. Silberberg-Robinson

11.441 Community Workshop I
Prereq: Permission of instructor
G (Fall)
3-2-4

11.442 Community Building Workshop II
Prereq: Permission of instructor
G (Spring)
3-2-4

Community workshops offered by The Center for Reflective Community Practice (CRCP). Subject centers on the social, economic, political, and technological complexities inherent in supporting the equitable development of poor and minority communities. The seminar/workshop format includes collaborative projects that include community residents, professionals and faculty. Each year the subject focuses on a particular issues facing one of the current CRCP community partnerships.

C. McDowell

11.444J The New Global Planning Practitioner (New)
(Same subject as 4.232J)
(Subject meets with 4.233)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject 4.232J.
R. Goethert

International Development and Regional Planning

11.462 Housing Problems and Policies in Developing Countries
Prereq: 11.701 or 11.426
G (Spring)
3-0-9 H-LEVEL Grad Credit

Focuses on the particular attributes, innovations, and methods of analysis of urban land and housing in developing and transition countries. Includes an overview of theory on supply and demand, tenure, standards, and community participation, detailed review of tools used in the field, and an examination of case studies revealing innovations in the field. Particular emphasis given to affordability and accessibility by the poor. Class format combines lectures, class projects, and presentation.

Consult Department Headquarters

11.463J Structuring Low-Income Housing Projects in Developing Countries
(Same subject as 4.236J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 4.236J.
R. Goethert

11.464 The Informal Sector and the Household Economy
Prereq: 11.701
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Examines interrelationships among low-income households, small-scale, income-generating activities, and the urban economy in developing countries. Theories of employment and an analysis of “bazaar economies” looked at. Reviews policy options for enhancing the informal sector’s contribution to development. The role of women and the possibilities of nonmonetary activities explored.

B. Sanyal

11.466J Sustainability, Trade, and the Environment
(Same subject as 1.813J, 15.657J, ESD.137J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject ESD.137J.
N. A. Ashford

11.467J Property Rights in Transition
(Same subject as 4.257J, 17.550J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Focuses on the property rights debates and conflicts that undergird many planning and development issues. Topics include their justification, ownership, norms and informal rights, institutions and formal rights, their role and externalities in the economy, takings and eminent domain. Uses international case studies as well as concepts of property rights from economic, political, legal and sociological perspectives.

A. M. Kim

11.468J SIGUS Workshop
(Same subject as 4.230J)
(Subject meets with 4.231)
Prereq: Permission of instructor
G (IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

See description under subject 4.230J.
R. Goethert

11.469 Urban Sociology in Theory and Practice
Prereq: Permission of instructor
G (Fall)
2-0-10 H-LEVEL Grad Credit

Introduction to core writings in urban sociology. Topics include: the changing nature of community, social inequality, political power, socio-spatial change, technological change, and the relationship between the built environment and human behavior. Examine key theoretical paradigms that have constituted the field since its founding, assess how and why they have changed over time, and discuss the implications of these paradigmatic shifts for urban scholarship, social policy and the planning practice. Explore the nature and changing character of the city and the urban experience, including the larger social, political, and economic dynamics of urban change, to enhance appreciation of contemporary, comparative, and historical context in which urban planning skills and sensibilities have been developed and could be applied.

D. E. Davis
11.470 The Politics of Development Policy
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Examines the political forces and conditions that affect urban, regional, and national development policymaking. Key protagonists include political parties, state actors, social movements, NGOs (domestic and global), business groups, and labor organizations, both formal and informal. Primary emphasis is the developing world, but seeks parallels across a variety of comparative and historical contexts.
D. E. Davis

11.471 Political Economy of Development Projects: Targeting the Poor
Prereq: 11.701 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Covers conditions under which public-sector policies, programs, and projects succeed in enhancing the economic activities of poorer groups and micro-regions in developing countries. Topics include local economic development; small enterprises; various forms of collective action; labor and worker associations; nongovernment organizations. Links these to literature on poverty, economic development, and reform of government, and to types of projects, tasks, and environments that are conducive to equitable outcomes.
J. Tendler

11.472 D-Lab: Development
(Subject meets with 11.025J, SP.721J)
Prereq: None
G (Fall)
2-2-7
Issues in international development, appropriate technology and project implementation addressed through lectures, case studies, guest speakers and laboratory exercises. Students form project teams to partner with community organizations in developing countries, and formulate plans for an optional IAP site visit. (Previous field sites include Ghana, Brazil, Honduras and India.) Recitation sections focus on specific project implementation, and include cultural, social, political, environmental and economic overviews of the target countries as well as an introduction to the local languages. Enrollment limited by lottery; must attend first class session.
A. B. Smith, B. Sanyal

11.477 Infrastructure in Crisis: Energy & Security Challenges (New)
(Subject meets with 11.165)
Prereq: 14.01 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.165.
K. Polenske

11.479 J Water and Sanitation Infrastructure in Developing Countries
(Same subject as 1.851J)
Prereq: None
G (Spring)
Units arranged
See description under subject 1.851J.
Consult Department Headquarters

11.480 Urbanization and Development
Prereq: None
G (Spring)
3-0-9
Examines developmental dynamics of rapidly urbanizing locales, with a special focus on the developing world. Case studies from India, China, Mexico, Brazil, and South Africa form the basis for discussion of social, spatial, political and economic changes in cities spurred by the decline of industry, the rise of services, and the proliferation of urban mega projects. Emphasizes the challenges of growing urban inequality, environmental risk, citizen displacement, insufficient housing, and the lack of effective institutions for metropolitan governance.

11.481 J Analyzing and Accounting for Regional Economic Change
(Same subject as 1.284J, ESD.192J)
Prereq: 14.03, 14.04
G (Spring)
3-0-9 H-LEVEL Grad Credit
Surveys theories of regional growth, factor mobility, clustering, industrial restructuring, learning regions, and global supply chains from a political-economy perspective. Examines critiques accounting frameworks including accounting for the underground economy, multipliers, linkages, and supply chains used to assess employment and environmental impacts, infrastructure investments. Assesses price indices, industrial location and employment measures, and shift-share analyses. Discussions of US and foreign applications.
K. R. Polenske

11.482 J Regional Socioeconomic Impact Analyses and Modeling
(Same subject as 1.285J, ESD.193J)
Prereq: 11.481J or permission of instructor
G (Fall)
2-1-9 H-LEVEL Grad Credit
Reviews regional economic theories and models and provides students with experience in using alternative economic impact assessment models on microcomputers. Problem sets are oriented around infrastructure, housing, energy, and environmental issues. Students work with a client generally in Boston and make a presentation to the client. Emphasis on written and oral presentation skills.
K. R. Polenske

11.483 Affordable Housing Solutions in Rapidly Urbanizing Areas
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Examines why the market regularly fails to deliver affordable housing. Provides an overview of theories of urban land markets, informality, and tools for modeling housing demand. Utilizes comparative case studies to identify the underlying factors that contribute to the success or failure of different affordable housing strategies. Posits that an understanding of property rights issues is key to developing successful policies and explores how that knowledge can be utilized to innovate new solutions, particularly in fast-growing cities.
A. M. Kim

11.484 Project Appraisal in Developing Countries
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Covers techniques of financial analysis of investment expenditures as well as the economic and distributive appraisal of development projects. Critical analysis of these tools and their role in the political economy of international development is also pursued. Topics include organizations and project cycle management, alternative planning strategies for conditions of uncertainty, the political environment and the interactions of clients and advisers, engineers, planners, policy analysts, and other professionals.
A. M. Kim
11.485 Planning in Transition Economies
Prereq: Permission of instructor
3-0-9 H-LEVEL Grad Credit
Surveys the recent historic transformation of former centrally planned economies in Europe and Asia. Topics include the reformulation of property rights, institutional development, the emergence of the private sector, the changing role of the state, the spatial transformation of cities, and the redistribution of wealth.
A. M. Kim

11.486J Economic Institutions and Growth Policy Analysis
(Same subject as 14.778J, 17.184J)
Prereq: 11.203
G (Spring)
3-0-6 H-LEVEL Grad Credit
Considers how institutions have been incorporated theoretically into explorations of growth and development. Four sets of institutions are examined in detail: the corporate sector, to study how ownership, strategy, and structure affect growth-related policies; financial institutions, to analyze how they condition savings and investment; labor market institutions, to investigate their impact on the determination of wage and production-related productivity; and the institutions associated with technology, such as universities, research laboratories, and corporate training centers, to consider how skill formation is accomplished.
A. Amsden, M. Piore

11.487 Urban Public Finance in Developing Countries
Prereq: 11.701, 11.426, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Explores the question of how to pay for urban public services in developing countries. Surveys both public finance theory and applied policy debates. Students gain facility in public finance analysis, familiarity with a variety of financing schemes and their strengths and weaknesses, and a general theoretical framework with which to approach real urban financing problems in developing countries.
Y. Hong

11.488 Urban Development in Conflict Cities: Planning Challenges and Policy Innovations
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Examines urban development challenges in conflict cities. Case studies used to examine the basic infrastructural, governance, social, and economic dilemmas facing citizens and local officials. First half of course focuses on the national and transnational context in which urban conflict is likely to persist; the impacts of conflict on social, political, economic, and institutional capacities of citizens, markets, and states, both local and national; and the growing involvement of multilateral development agencies in identifying urban conflict as a barrier to economic growth. Course ends with a focus on policy innovations, and examination of potential planning, design, and policy solutions.
D. Davis

11.489 The Growth and Spatial Structure of Cities
Prereq: None
G (Spring)
3-0-9
Examines the economic, political, social, and spatial dynamics of urban growth and decline in cities and their key component areas (downtown, suburbs, etc.). Topics include impacts of industrialization, technology, politics, and social practices on cities. Examines the role of public and private sector activities, ranging from zoning and subsidies to infrastructure development and real estate investment, in affecting urban growth and decline. Readings are both theoretical and empirical, with considerable thought paid to comparative and historical differences.
D. Davis

11.490 Law and Development (New)
Prereq: Permission of instructor
G (Spring)
2-0-10 H-LEVEL Grad Credit
Examines the role of law in development and introduces economic and legal theories. Topics include formality/informality of property, contracts and “bargaining in the shadow” of the law, institutions for transparency and accountability, legitimation of law, sequencing of legal reform, and international economic law aspects. Studies the roles of property rights in economic development, the judiciary and the bureaucracy in development, and law in aid policy. Includes selected country case studies. Limited to 15.
B. Rajagopal

11.491J Economic Development and Policy Analysis I
(Same subject as 17.176J)
Prereq: 11.701
G (Fall)
3-0-9 H-LEVEL Grad Credit
Analyzes the theoretical and historical reasons why governments in latecomer countries have intervened with a wide array of policies to foster industrial development at various turning points: the initiation of industrial activity; the diversification of the industrial base; the restructuring of major industrial institutions; and the entry into high-technology sectors.
A. Amsden

11.492J Economic Development and Policy Analysis, Part II
(Same subject as 17.190J)
Prereq: 11.491J
G (Spring)
3-0-9 H-LEVEL Grad Credit
Analyzes economic development in “the remainder,” or in countries that largely failed to enter the orbit of modern world industry since the end of World War II. Looks at the reasons for falling behind in terms of history, geography/global transactions, institutions (including business enterprises), policies and knowledge-based assets. Explores potential policies for accelerating the process of industrial transformation and the control mechanism necessary to improve government planning.
A. Amsden

11.493 Legal Aspects of Property and Land Use
Prereq: None
G (Fall)
3-0-9
Examines legal and institutional arrangements for the establishment, transfer, and control over property under American and selected comparative systems including India and South Africa. Focuses on key issues of property and land use law regarding planning and economic development. Emphasizes efficient resource use; institutional, entitlement and social relational approaches to property; distributional and other social aspects; and the relationship between property, culture, and democracy.
B. Rajagopal
11.494 City and the Law
Prereq: None
G (Spring)
3-0-9
Introduction to the legal and institutional issues that arise in local and city governance. Focuses on the way institutional arrangements and legal concepts influence how power is distributed, how it is exercised and by whom, and explores alternative arrangements. Illustrations from American local government law, and examples from comparative law.
B. Rajagopal

11.495 Governance and Law in Developing Countries
Prereq: Permission of instructor
G (Fall)
2-0-10 H-LEVEL Grad Credit
Examines the multiple dimensions of governance in international development with a focus on the role of legal norms and institutions in the balance between state and the market. Analyzes changes in the distribution of authority, political and legal, as a result of economic globalization. Topics include the role and reform of the state, the role of civil society and markets, global governance, good governance, the role of the judiciary and legal culture in development and tools for measuring governance performance.
B. Rajagopal

11.496 Law, Social Movements, and Public Policy: Comparative and International Experience
(Subject meets with 11.166)
Prereq: Permission of instructor
G (Spring)
3-0-9
Examines the role that law, courts and social movements play in shaping public policy, at the global level and within selected countries. Primary focus on the interplay between law, social movements and public policy in current areas such as gender, race, labor, trade, environment, and human rights. Introduction to theories of public policy, social movements, law and society, and transnational studies. Research paper required for graduate students. Open to undergraduates with permission of instructor.
B. Rajagopal

11.497 Human Rights in Theory and Practice
(Subject meets with 11.164J, 17.391J)
Prereq: None
G (Fall)
3-0-9
Provides a rigorous and critical introduction to the foundation, structure and operation of the human rights movement. Focuses on key actors, methods, and sources. Addresses current debates in human rights, including democracy promotion, economic and social rights in development and globalization, gender and race discrimination, religion, use of military force and humanitarian intervention, post-conflict rebuilding, transitional justice, terrorism, and ethical issues in science and technology. Graduate students are expected to write a research paper.
B. Rajagopal

11.520 A Workshop on Geographic Information Systems
Prereq: Permission of instructor
G (Fall)
3-6-3 H-LEVEL Grad Credit
Credit cannot also be received for 11.188
An introduction to geographic information systems (GIS) as applied to urban and regional planning, community development, and local government. Emphasis on learning GIS technology and spatial analysis techniques through extensive hands-on exercises using real-world data sets such as the US census of population and housing. Includes a small project on an urban planning problem involving the selection of appropriate methods, the use of primary and secondary data, computer-based modeling, and spatial analysis.
J. Ferreira

11.521 Spatial Database Management and Advanced Geographic Information Systems
Prereq: Permission of instructor; or 11.520 and Coreq: 11.220
G (Spring)
3-3-6 H-LEVEL Grad Credit
Credit cannot also be received for 11.523, 11.524
Extends the computing and geographic information systems (GIS) skills developed in 11.520 to include spatial data management in client/server environments and advanced GIS techniques. First half covers the content of 11.523, introducing database management concepts, SQL (Structured Query Language), and enterprise-class database management software. Second half explores advanced features and the customization features of GIS software that perform analyses for decision support that go beyond basic thematic mapping. Includes the half-term GIS project of 11.524 that studies a real-world planning issue.
J. Ferreira

11.522 Research Seminar on Urban Information Systems
Prereq: 11.521; 11.520 or 11.525
G (Fall)
2-4-6 H-LEVEL Grad Credit
Can be repeated for credit
Advanced research seminar enhances computer and analytic skills developed in other subjects in this sequence. Students present a structured discussion of journal articles representative of their current research interests involving urban information systems and complete a short research project. Suggested research projects include topics related to ongoing UIS Group research.
J. Ferreira

11.523 Fundamentals of Spatial Database Management
Prereq: Permission of instructor
G (Spring; first half of term)
2-2-2 H-LEVEL Grad Credit
Credit cannot also be received for 11.521, 11.524
The fundamentals of database management systems as applied to spatial analysis. Includes extensive hands-on exercises using real-world planning data. Introduces database management concepts, SQL (Structured Query Language), and enterprise-class database software. Same content as first half of 11.521.
J. Ferreira

11.524 Advanced Geographic Information System Project
Prereq: 11.523 or permission of instructor
G (Spring; second half of term)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Credit cannot also be received for 11.521, 11.523
Learning and utilizing advanced geographic information system techniques in studio/lab setting with real-world client problem and complex digital spatial data infrastructure. Projects typically use the client and infrastructure setting for 11.521. Credit cannot also be received for 11.521 in the same term.
J. Ferreira
11.525 Emerging Technologies for Planners
Prereq: Permission of instructor
G (Spring)
3-2-7 H-LEVEL Grad Credit
Students are familiarized with the changing technologies available for manipulating, organizing, and presenting visually-oriented electronic information for the description of urban environmental phenomena. Students are exposed to cases where these technologies have been used, or are in use, by planning-related agencies. Impacts of these technologies upon public debate and decision making are studied. Specific attention is paid to multimedia and communication technologies and how these have the ability to change the way people plan.
Staff

11.526J Comparative Land Use and Transportation Planning
(Same subject as 1.251J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Focuses on the integration of land use and transportation planning, drawing from cases in both industrialized and developing countries. Reviews underlying theories, analytical techniques, and the empirical evidence of the land use-transportation relationship at the metropolitan, intra-metropolitan, and micro-scales. Also covers the various ways of measuring urban structure, form, and the “built environment.” Develops students’ skills to assess relevant policies, interventions and impacts.
C. Zegras

11.528J Urban Spatial Structure, Transportation, and Telecommunications I
(Same subject as ESD.229J)
Prereq: Permission of instructor
G (Spring)
3-1-2 H-LEVEL Grad Credit
Discusses the meanings of urban space and the role of transportation planning in a contemporary metropolitan context. Topics include formation and evolution of land use patterns; job accessibility of low-skilled workers; strategies for improving accessibility; integration of transportation planning with housing, social service, and job placement; and impact of advanced communication and information technologies on urban space. Applies spatial analysis, GIS, and transportation planning methods to a case study of Boston.
Staff

11.529 Urban Spatial Structure, Transportation, and Telecommunications II
Prereq: 11.528 or permission of instructor
G (Spring)
0-3-3 H-LEVEL Grad Credit
Extends the analytical frameworks developed in 11.528J and applies them to the examination of urban land use, transportation, and telecommunications-related problems. Sheds light on ongoing policy debates by analyzing empirical data using GIS and spatial models. Students undertake a short research project individually or participate in a group project.
Staff

11.530 Community and Technology
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
2-0-10 H-LEVEL Grad Credit
Critical overview of recent studies on the social implications of new media on community, networks and society. Topics include personal computing, Internet use, mobile phones, virtual community, blogs, etc. Critical evaluation of empirical studies, use of social network analysis, and research projects address sociological research questions.
Staff

11.533 Ecological Planning with GIS
Prereq: 11.205
G (Spring; first half of term)
2-2-2
Provides a practical introduction to spatial environmental assessment and planning methods at landscape to regional scales. Lectures and discussions focus on key concepts in landscape ecology as well as the data and methods needed to incorporate these concepts in environmental planning. Weekly lab exercises demonstrate how natural systems are represented in modern geographic information systems, how to synthesize information using overlay analysis and suitability modeling, and design methods that build on the resulting syntheses. Features raster GIS analysis methods. Students interested in conducting an applied project in this area are encouraged to register for 11.524 for the second half of the term.
M. Flaxman

11.540J Urban Transportation Planning
(Same subject as 1.252, ESD.225J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.252J.
F. Salvucci, M. Murga

11.541J Public Transportation Systems
(Same subject as 1.258J, ESD.226J)
Prereq: 1.201J or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.258J.
N. H. M. Wilson

11.543J Transportation Policy and Environmental Limits
(Same subject as 1.253J, ESD.222J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.253J.
J. Coughlin, F. Salvucci

11.544J Transportation Systems Analysis: Performance and Optimization
(Same subject as 1.200J, ESD.21J)
Prereq: 1.010, permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 1.200J.
C. Barnhart, A. R. Odoni

11.545J Transportation Systems Analysis: Demand and Economics
(Same subject as 1.201J, ESD.210J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 1.201J.
N. H. M. Wilson, M. Ben-Akiva

11.601 Introduction to Environmental Policy and Planning
Prereq: None
G (Fall)
3-0-9
Required introductory subject for graduate students pursuing environmental policy and planning as their specialization in the MCP Program. Also open to other graduate students interested in environmental policy-making and the practice of environmental planning. Taught comparatively, with numerous references to examples from around the world. Four major areas of focus: National Environmental Policy-making,
Environmental Ethics, Environmental Forecasting and Analysis Techniques, and Strategies for Collaborative Decision-making.

L. Susskind

11.630J Environmental Law, Policy, and Economics: Pollution Prevention and Control
(Same subject as 1.811J, ESD.133J)
(Subject meets with 1.801J, 11.021J, 17.393J)
Prereq: Permission of instructor for undergraduates
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.811J.
N. A. Ashford, C. C. Caldart

11.631J Regulation of Chemicals, Radiation, and Biotechnology
(Same subject as 1.812J, ESD.134J)
(Subject meets with 1.802J, 11.022J)
Prereq: Permission of instructor for undergraduates
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.812J.
N. A. Ashford, C. C. Caldart

11.701 Introduction to International Development Planning
Prereq: None
G (Fall)
3-0-9
Interaction between planners and institutions at both national and local levels. Overview of theories of state, organizational arrangements, implementation mechanisms, and planning styles. Case studies of planning: decentralization, provision of low-cost housing, and new-town development. Analyzes various roles planners play in different institutional contexts. Professional ethics and values amidst conflicting demands. Restricted to first-year MCP and SPURS students.
B. Rajagopal

Tutorials, Research, and Field Work Subjects

11.800 Doctoral Research Seminar
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Required subject for all entering PhD students. Dual focus is on formulating researchable questions (to help students write their first-year papers) and understanding how research knowledge comes to be influential in the world or not influential. Explores ways to make research knowledge more accessible, credible, and useful in the realm of public policy and practice. Addresses the politics of the policymaking process, the power of framing and agenda-setting, how knowledge diffuses along knowledge and influence networks, and how varied types of knowledge shape decision-making and action.
D. Davis

11.900 Doctoral Seminar
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Designed primarily for advanced doctoral candidates. A selection of seminars is offered each year for groups of students affiliated with the various research clusters in the Department.
Staff

11.901, 11.902 Research Seminar: Topics in Urban Studies and Planning
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Special research issues in urban planning, selected each term for special study.
Staff

11.911, 11.912 Supervised Readings in Urban Studies
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Reading and discussion of special topics in urban studies and planning.
Staff

11.913 Special Topics in Urban Studies and Planning
Prereq: None
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Special topics in Urban Studies and Planning.
Staff

11.921, 11.922 Special Seminars in Real Estate Development
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for group study by graduate students on current topics related to real estate not otherwise included in the curriculum.
Staff

11.941–11.955 Special Studies in Urban Studies and Planning
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Small group study of advanced subjects under staff supervision. For graduate students wishing to pursue further study in advanced areas of urban studies and city and regional planning not covered in regular subjects of instruction.
Staff

11.956–11.959 IAP Special Studies in Urban Studies and Planning
Prereq: Permission of instructor
G (IAP)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Special subjects offered during IAP.
Staff

11.960, 11.961 Special Studies in Real Estate
Prereq: None
G (IAP, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Special subjects offered during IAP and summer.
Staff
11.962 Urban Fieldwork and Internships
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Practical application of planning techniques to towns, cities, and regions, including problems of replanning, redevelopment, and renewal of existing communities. Includes internships, under staff supervision, in municipal and state agencies and departments.
Staff

11.963–11.969 Special Studies in Urban Studies and Planning
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Small group study of advanced subjects under staff supervision. For graduate students wishing to pursue further study in advanced areas of urban studies and city and regional planning not covered in regular subjects of instruction.
Staff

11.970 Special Studies in Urban Studies and Planning
Prereq: None
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Small group study of advanced subjects under staff supervision. For graduate students wishing to pursue further study in advanced areas of urban studies and city and regional planning not covered in regular subjects of instruction.
Staff

11.981 Graduate Tutorial
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit
11.982 Doctoral Tutorial
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Planned programs of instruction for a minimum of three doctoral students. Students and faculty members must make arrangements prior to the beginning of the term.
E. Ben-Joseph

11.983 SPURS Seminar
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Provides skills to enable SPURS Fellows to grasp complex issues of urban and regional change. Aims to facilitate professional interactions with scholars, policy makers, and practitioners in the field. MIT faculty and outside specialists share expertise on issues related to globalization, urban development, infrastructure, and public policy. Fellows present their professional interests and research, and hone practical and professional skills. Fellows prepare a research paper that addresses an important issue in their practice and conducts an examination of that issue. Final research paper is presented to the larger MIT community. SPURS Fellows only.
Staff

11.985 Summer Thesis Writing
Prereq: None
G (Summer)
Units arranged
Designed to be used specifically for thesis writing and research during the summer.
L. Vale

11.971 IAP Special Studies in Urban Studies and Planning
Prereq: None
G (IAP)
Units arranged [P/D/F]
11.972–11.975 IAP Special Studies in Urban Studies and Planning
Prereq: None
G (IAP)
Units arranged
IAP Subject.
Staff

11.974 Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research and writing of thesis; to be arranged by the student with supervising committee.
Staff
## Bachelor of Science in Planning/Course 11

### General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [four subjects can be satisfied by subjects in the Departmental Program]</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 11.188 in the Departmental Program]</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

### Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

### PLUS Departmental Program

<table>
<thead>
<tr>
<th>Subject Names Below Are Followed by Credit Units, and by Prerequisites if Any (Corequisites in Italic)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Subjects</strong></td>
</tr>
<tr>
<td>11.001J Introduction to Urban Design and Development, 12, HASS</td>
</tr>
<tr>
<td>11.002J Making Public Policy, 12, HASS-D, CI-H</td>
</tr>
<tr>
<td>11.123J Big Plans, 9, HASS</td>
</tr>
<tr>
<td>14.01J Principles of Microeconomics, 12, HASS</td>
</tr>
<tr>
<td>11.188J Urban Planning and Social Science Laboratory, 12, LAB, CI-M; permission of instructor</td>
</tr>
</tbody>
</table>

| **Planned Electives**                                                                            | **57**   |
| Majors in Course 11 are required to formulate or select one stream of coursework for concentration. |          |
| They can select from the following recommended options or create their own stream tailored to a particular set of urban, policy, or planning concerns. |          |

#### Urban and Environmental Policy and Planning

<table>
<thead>
<tr>
<th>Subject Name</th>
<th>Credit Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.011J The Art and Science of Negotiation</td>
<td>12</td>
</tr>
<tr>
<td>11.014J American Urban History II</td>
<td>9</td>
</tr>
<tr>
<td>11.016J The Once and Future City</td>
<td>12, CI-H</td>
</tr>
<tr>
<td>11.026J Downtown</td>
<td>9</td>
</tr>
<tr>
<td>11.027J Society and Environment</td>
<td>12</td>
</tr>
<tr>
<td>1.011J Project Evaluation</td>
<td>9</td>
</tr>
<tr>
<td>1.043J Engineering System Design</td>
<td>12, 1.011*</td>
</tr>
</tbody>
</table>

#### Urban Society, History, and Politics

<table>
<thead>
<tr>
<th>Subject Name</th>
<th>Credit Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.013J American Urban History I</td>
<td>9, HASS</td>
</tr>
<tr>
<td>11.014J American Urban History II</td>
<td>9, HASS</td>
</tr>
<tr>
<td>11.015J Riots, Strikes, and Conspiracies in American History</td>
<td>12, CI-H</td>
</tr>
<tr>
<td>11.020J Poverty, Public Policy, and Controversy</td>
<td>12, HASS</td>
</tr>
<tr>
<td>11.023J Bridging Cultural and Racial Differences</td>
<td>12, HASS</td>
</tr>
<tr>
<td>11.024J Great Cities</td>
<td>9, HASS</td>
</tr>
<tr>
<td>11.026J Downtown</td>
<td>9, HASS</td>
</tr>
<tr>
<td>11.330J Theory of City Form, units arranged</td>
<td>11.001J*</td>
</tr>
</tbody>
</table>

#### Urban and Regional Public Policy

<table>
<thead>
<tr>
<th>Subject Name</th>
<th>Credit Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.003J Methods of Public Policy Analysis</td>
<td>12, HASS; 11.002J, 17,30, 14.01</td>
</tr>
<tr>
<td>11.005J Introduction to International Development</td>
<td>12</td>
</tr>
<tr>
<td>11.011J The Art and Science of Negotiation</td>
<td>12, HASS</td>
</tr>
<tr>
<td>11.020J Poverty, Public Policy, and Controversy</td>
<td>12, HASS</td>
</tr>
<tr>
<td>11.025J D-Lab: Development</td>
<td>12, permission of instructor</td>
</tr>
<tr>
<td>11.126J Economics of Education</td>
<td>12, HASS; 14.01</td>
</tr>
<tr>
<td>11.166J Law, Social Movements, and Public Policy</td>
<td>12, HASS; permission of instructor</td>
</tr>
</tbody>
</table>

#### Urban Field Experience

Declared majors are encouraged to take the optional urban field experience subject.

11.027J City to City (CI-M) is taught in the spring and includes a trip during spring break. This course may be taken multiple times, as the content differs each year, but may only be counted once as a planned elective.

#### Thesis

Majors are required to write a senior thesis or complete a senior project. The thesis/project writing process is accompanied by a required undergraduate thesis preparation seminar, which meets in the fall.

11.ThT Thesis Research Design Seminar, 12, CI-M

Departmental Program Units That Also Satisfy the GIRs  
Unrestricted Electives  

Total Units Beyond the GIRs Required for SB Degree 180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes
* Alternate prerequisites and corequisites are listed in the subject description.
Course 11 majors are not permitted to have a HASS concentration in Urban Studies.
For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
UNDERGRADUATE SUBJECTS

12.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

12.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Undergraduate research opportunities in Earth, Atmospheric, and Planetary Sciences.

12.017 Introduction to Geology
Prereq: None
U (Spring)
3-4-5 REST

Major minerals and rock types, rock-forming processes, and time scales. Temperatures, pressures, compositions, structure of the Earth, and measurement techniques. Geologic structures and relationships observable in the field. Sediment movement and landform development by moving water, wind, and ice. Crustal processes and planetary evolution in terms of global plate tectonics with an emphasis on ductile and brittle processes. Includes laboratory exercises on minerals, rocks, mapping, plate tectonics, rheology, glaciers. Two one-day field trips (optional).

L. Elkins-Tanton

12.002 Physics and Chemistry of the Terrestrial Planets
Prereq: Physics II (GIR), Calculus II (GIR)
U (Fall)
3-1-8 REST

Study of the structure, composition, and physical processes governing the terrestrial planets, including their formation and basic orbital properties. Topics include plate tectonics, earthquakes, seismic waves, rheology, impact cratering, gravity and magnetic fields, heat flux, thermal structure, mantle convection, deep interiors, planetary magnetism, and core dynamics. Suitable for majors and non-majors seeking general background in geophysics and planetary structure.

L. H. Royden, B. Weiss

12.003 Physics of the Atmosphere and Ocean
Prereq: Calculus II (GIR), Physics I (GIR)
U (Fall)
3-1-8 REST

The laws of classical mechanics and thermodynamics are used to explore how the properties of fluids on a rotating Earth manifest themselves in, and help shape, the global patterns of atmospheric winds, ocean currents, and the climate of the Earth. Theoretical discussion focuses on the physical processes involved. Underlying mechanisms are illustrated through laboratory demonstrations, using a rotating table, and through analysis of atmospheric and oceanic data.

J. Marshall

12.005 Applications of Continuum Mechanics to Earth, Atmospheric, and Planetary Sciences
Prereq: Physics II (GIR), Calculus II (GIR);
Coreq: 18.03
U (Spring)
3-2-7

Practical applications of the continuum concept for deformation of solids and fluids, emphasizing force balance. Stress tensor, infinitesimal and finite strain, and rotation tensors are developed. Constitutive relations applicable to geological materials, including elastic, viscous, brittle, and plastic deformation. Laboratory
component provides specific examples of elastic and inelastic mechanical behavior of rocks and illustrates several methods of measurement in the laboratory.

A. Malcolm, B. Evans

12.006J Nonlinear Dynamics I: Chaos
(Same subject as 2.050J, 18.353J)
Prereq: 18.03 or 18.034; Physics II (GIR)
U (Fall)
3-0-9

T. Peacock

12.007 Geobiology
Prereq: None
U (Spring)
3-0-9
The interactive Earth system: biology in geologic, environmental and climate change throughout Earth history. Since life began it has continually shaped and re-shaped the atmosphere, hydrosphere, cryosphere and the solid earth. Introduces the concept of “life as a geological agent” and examines the interaction between biology and the earth system during the roughly 4 billion years since life first appeared. Topics include the origin of the solar system and the early Earth atmosphere; the origin and evolution of life and its influence on climate up through and including the modern age and the problem of global warming; the global carbon cycle; and astrobiology.

R. Summons

12.010 Computational Methods of Scientific Programming
Prereq: Calculus I (GIR), Calculus II (GIR), Physics I (GIR)
U (Fall)
4-0-8
Introduces programming languages and techniques used by physical scientists: FORTRAN, C, C++, MATLAB, and Mathematica. Emphasis on program design, algorithm development and verification, and comparative advantages and disadvantages of different languages. Students first learn the basic usage of each language, common types of problems encountered, and techniques for solving a variety of problems encountered in contemporary research: examination of data with visualization techniques, numerical analysis, and methods of dissemination and verification. No prior programming experience is required.

T. Herring, C. Hill

12.011J Archaeological Science
(Same subject as 3.985J, 5.24J)
Prereq: Chemistry (GIR) or Physics I (GIR)
U (Spring)
3-1-5 HASS
See description under subject 3.985J.

H. N. Lechtman, J. Stubbe, F. A. Frey

12.021 Earth Science, Energy, and the Environment (New)
Prereq: Physics I (GIR), Calculus I (GIR), Chemistry (GIR)
U (Fall)
3-0-9
Provides understanding of the Earth System most relevant to production of our planet’s natural energy resources, including the physics, chemistry, and biology of conventional and alternative energy sources. Includes a broad overview of traditional and alternative energy sources: hydrocarbons (conventional and unconventional), nuclear, geothermal, hydroelectric, and wind and tides, along with their potentials and limitations. Develops detailed knowledge of the formation, concentration, and production of fossil and nuclear fuels, as well as the waste products associated with their consumption. An examination of conventional and alternative energy sources includes the environmental issues associated with the exploitation of these resources, both regional and global.

EAPS staff

12.080 EAPS Undergraduate Seminar
Prereq: None
U (Fall, Spring)
1-0-2 [P/D/F]
Can be repeated for credit
Covers topics in earth, atmospheric, and planetary sciences. Weekly seminars are presented by EAPS faculty members. Short weekly reading and writing assignments based on the seminar topics.

Staff

12.085 Seminar in Environmental Science
Prereq: 12.120 and 12.103, or permission of instructor
U (Spring)
3-0-6
Stresses integration of central scientific concepts in environmental policy making and the chemistry, biology, and geology environmental science tracks. Revisits selected core themes for students who have already acquired a basic understanding of environmental science concepts. Potential topics include: geology, geochemistry and the politics of nuclear waste disposal; responsible environmental practices for planetary exploration; responsible coastal land-use policy; international regulations for protecting the open-ocean environment; the ecological impact of environmental change; and effective policy for dealing with natural hazards near major cities.

D. H. Rothman

12.086 Modeling Environmental Complexity
(Subject meets with 12.586)
Prereq: 18.03
U (Fall)
3-0-9
Introduction to mathematical and physical models of environmental processes. Emphasis on the development of macroscopic continuum or statistical descriptions of complex microscopic dynamics. Problems of interest include: random walks and statistical geometry of landscapes; percolation theory and transport in disordered media; fractals, scaling, and universality; ecological dynamics and the structure of ecosystems, food webs, and other natural networks; kinetics of biogeochemical cycles. Appropriate for advanced undergraduates. Beginning graduate students are encouraged to register for 12.586. Students taking the graduate version complete different assignments.

D. H. Rothman
12.090 Special Topics in Earth, Atmospheric, and Planetary Sciences
Prereq: Permission of instructor
U (fall, IAP, spring)
Units arranged
Can be repeated for credit

12.091 Special Topics in Earth, Atmospheric, and Planetary Sciences
Prereq: Permission of instructor
U (fall, IAP, spring)
Units arranged
Can be repeated for credit

Laboratory or field work in earth, atmospheric, and planetary sciences. Consult with department Education Office.
EAPS Faculty

12.092 Special Topics in Geology and Geochemistry
Prereq: None
U (fall, IAP, spring)
Units arranged
Can be repeated for credit

12.093 Special Topics in Geology and Geochemistry
Prereq: Permission of instructor
U (fall, IAP, spring)
Units arranged [P/D/F]
Can be repeated for credit

Laboratory or field work in geology and geochemistry. To be arranged with department faculty. Consult with department Education Office.
EAPS Faculty

12.094 Special Topics in Geophysics
Prereq: Permission of instructor
U (fall, IAP, spring)
Units arranged
Can be repeated for credit

12.095 Special Topics in Geophysics
Prereq: Permission of instructor
U (fall, IAP, spring)
Units arranged [P/D/F]
Can be repeated for credit

Laboratory or field work in geophysics. To be arranged with department faculty. Consult with department Education Office.
EAPS Faculty

12.096 Special Topics in Atmospheric Science and Oceanography
Prereq: Permission of instructor
U (fall, IAP, spring)
Units arranged
Can be repeated for credit

12.097 Special Topics in Atmospheric Science and Oceanography
Prereq: Permission of instructor
U (fall, IAP, spring)
Units arranged [P/D/F]
Can be repeated for credit

Laboratory or field work in atmospheric science and oceanography. To be arranged with department faculty. Consult with department Education Office.
EAPS Faculty

12.099 Special Topics in Planetary Science
Prereq: Permission of instructor
U (fall, IAP, spring)
Units arranged
Can be repeated for credit

12.102 Environmental Earth Science
Prereq: None
U (fall)
3-0-9 REST

The geologic record demonstrates that our environment has changed over a variety of time scales from seconds to billions of years. Explores the many ways in which geologic processes control and modify the Earth's environment. Topics include chemical and physical interactions between the solid Earth, its oceans and atmosphere; the effect of catastrophic events such as volcanic eruptions and earthquakes on the environment; geologic hazards; and our role in modifying the environment through Earth resource development. Serves as an introduction to 12.120, which addresses field applications of these principles in the American Southwest.
F. A. Frey, T. L. Grove

12.103 The Science and Policy of Natural Hazards
Prereq: None
U (spring)
3-0-9

Examines the science of natural catastrophes such as earthquakes and hurricanes and explores the relationships between the science of and policy toward such hazards. Presents the causes and effects of these phenomena, discusses their predictability, and examines how this knowledge influences policy making. Includes intensive practice in the writing and presentation of scientific research and summaries for policy makers.
K. Emanuel, S. Rondenay

12.104 Geochemistry of the Earth and Planets
Prereq: Calculus II (GIR)
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (fall)
3-1-8

Focuses on the processes that create chemical variability in the solid and fluid Earth, the moon, and meteorites. Includes nucleosynthesis, cosmochronology, and basic geochemical concepts. Thermodynamics and phase equilibria are introduced and applied to problems of melting solid planetary interiors and the evolution of the Earth's hydrosphere. Radiogenic and stable isotopic systems are used to document the timing of planetary formation and differentiation, formation, and evolution of volcanoes and continental crust, and to understand interactions between the solid and fluid Earth.
F. A. Frey, T. L. Grove

12.106 Special Topics in Atmospheric Science and Oceanography
Prereq: Permission of instructor
U (fall, IAP, spring)
Units arranged
Can be repeated for credit

12.107 Special Topics in Atmospheric Science and Oceanography
Prereq: Permission of instructor
U (fall, IAP, spring)
Units arranged [P/D/F]
Can be repeated for credit

Laboratory or field work in atmospheric science and oceanography. To be arranged with department faculty. Consult with department Education Office.
EAPS Faculty

12.108 Structure of Earth Materials
Prereq: Chemistry (GIR)
U (spring)
3-4-5

Provides a comprehensive introduction to crystalline structure, crystal chemistry, and bonding in rock-forming minerals. Introduces the theory relating crystal structure and crystal symmetry to physical properties such as refractive index, elastic modulus, and seismic velocity. Survey the distribution of silicate, oxide, and metallic minerals in the interiors and on the surfaces of planets, and discusses the processes that led to their formation.
T. L. Grove, S.-H. Shim
12.109 Petrology
Prereq: 12.108
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-6-3
Surveys the distribution, chemical composition, and mineral associations in rocks of the Earth’s crust and upper mantle, and establishes its relation to tectonic environment. Emphasis is on the use of chemistry and physics to interpret rock forming processes. Topics include dynamics of crust and mantle melting as preserved in the chemical composition of igneous rocks and minerals, the long-term record of global climate change as preserved in the minerals of sedimentary rocks, and the time-temperature-depth record preserved in minerals of metamorphosed crustal rocks.
T. L. Grove

12.110 Sedimentary Geology
(Subject meets with 12.465)
Prereq: 12.001
U (Spring)
3-3-6
J. B. Southard

12.111 Mechanics of Sedimentary Processes
(Subject meets with 12.452)
Prereq: Permission of instructor
U (Spring)
3-0-9
Studies aspects of flow and sediment-transport mechanics relevant to understanding the construction of landscapes and depositional systems including modes of particle entrainment and motion in turbulent shear flows; sediment-bed configurations; channelization, erosion, and deposition of cohesive sediments; sediment gravity flows; and sorting of sediments by particle size and density. Interpretation of primary structures and textures in modern and ancient sedimentary deposits on the basis of sediment-transport mechanics. Meets with 12.452 but assignments differ.
EAPS Staff

12.113 Structural Geology
Prereq: 12.001, 12.005
U (Fall)
3-3-6
Introduces mechanics of rock deformation. Discusses recognition, interpretation, and mechanics of faults, folds, structural features of igneous and metamorphic rocks, and superposed deformations. Introduces regional structural geology and tectonics. Laboratory includes techniques of structural analysis, recognition and interpretation of structures on geologic maps, and construction of interpretive cross sections.
B. C. Burchfiel, O. Jagoutz

12.114 Field Geology I
Prereq: 12.108 or permission of instructor; or Coreq: 12.113
U (Fall)
2-2-2 [P/D/F]
Introduces techniques of geological field study. Weather permitting, several weekend field exercises provide practical experience in preparation for 12.115. Presents introductory material on the regional geography of the locale of 12.115.
B. C. Burchfiel, O. Jagoutz

12.115 Field Geology II
Prereq: 12.113, 12.114
U (IAP, Spring)
0-18-0 Institute LAB
During January, students practice methods of modern geological field study during an intensive four-week subject. Exercises include geological and geomorphological mapping on topographic and photographic base maps of a wide variety of bedrock and surficial rocks. Where feasible, geochemical and geophysical field measurements are correlated with geology. Following term includes preparation of reports based on field studies conducted during January; report generally exceeds 30 pages in length and includes one major revision and rewrite. Instruction in writing techniques provided. Laboratory analysis of samples, interpretation of geological data, and where possible, geophysical and geochemical data. 12 units may be applied to the General Institute Laboratory Requirement.
Geology and Geochemistry Staff

12.119 Analytical Techniques for Studying Environmental and Geologic Samples
Prereq: None
U (Spring)
2-6-4 Institute LAB
Focuses on analytical facilities that are used to determine elemental and isotopic abundances in soils, rocks, minerals, and fluids. Emphasis is on isotopic ratios Sr, Nd, and Pb, whose isotopic ratios can be used for geochronology, and abundances of trace elements such as Rb, Sr, Cu, Cd, Hg, rare-earths, Pb, Th, and U. Analytical techniques include mass spectrometry, emission spectrometry, atomic absorption, neutron activation, and electron microprobe. A major lab project utilizes these techniques to address specific environmental and geologic problems.
S. Bowring, E. Boyle, F. Frey, T. Grove

12.120 Environmental Earth Science Field Course
Prereq: Permission of instructor
U (IAP)
1-5-0
Field study to foster understanding of natural hazards and human influence on the environment. Class conducted in the western United States, at locations such as Death Valley and the White Mountain Research Station in Bishop California. Topics include water use and availability, climate change, earthquakes and faulting, and landslides. Also examines volcanic hazards and geothermal power, effects of river diversion, and the geology of the Yucca Mountain facility for the storage of radioactive waste. Students partially responsible for travel expenses. Designed to follow 12.001 or 12.102; other students will be accepted when space is available.
S. Bowring, T. L. Grove

12.141 Electron Microprobe Analysis
Prereq: None
U (IAP)
1-1-4 [P/D/F]
Introduction to the theory of x-ray microanalysis through the electron microprobe including ZAF matrix corrections. Techniques to be discussed are wavelength and energy dispersive spectrometry, scanning backscattered electron, secondary electron, cathodoluminescence, and x-ray imaging. Lab sessions involve use of the electron microprobe.
T. Grove, N. Chatterjee

12.159 Sedimentary and Surficial Geology Investigations
(Subject meets with 12.459)
Prereq: 12.110 or permission of instructor
U (Spring)
3-6-3
Can be repeated for credit
See description under subject 12.459.
D. Rothman
12.163 Geomorphology
(Subject meets with 12.463)
Prereq: 12.001, Physics I (GIR), Calculus I (GIR); or permission of instructor
U (Fall)
3-3-6
Quantitative examination of processes that shape Earth’s surface. Introduction to fluvial, hillslope, and glacial mechanics. Essentials of weathering, soil formation, runoff, erosion, slope stability, sediment transport, and river morphology. Landscape evolution in response to climatic and tectonic forcing. Application of terrestrial theory to planetary surfaces. Additional instruction in geographic information systems (GIS) and remote sensing analysis, field measurement techniques, and numerical modeling of surface processes. Students taking the graduate version complete different assignments.
T. Perron

Geophysics

12.201 Essentials of Geophysics
(Subject meets with 12.501)
Prereq: Physics II (GIR), 18.03
U (Fall)
4-0-8
See description under subject 12.501.
R. D. van der Hilst

12.207J Nonlinear Dynamics II: Continuum Systems
(Same subject as 18.354J)
Prereq: 18.353J/12.006J or permission of instructor
U (Spring)
3-0-9 H-LEVEL Grad Credit (except for Course 18 students)
See description under subject 18.354J.
P. M. Reis

12.213 Alternate Energy Sources
Prereq: None
U (IAP)
1-4-1 [P/D/F]
Can be repeated for credit
Explores a number of alternative energy sources such as geothermal energy (heat from the Earth’s interior), wind, natural gas, and solar energy. Includes a field trip to visit sites where alternative energy is being harvested or generated. Content and focus of subject varies from year to year.
M. N. Toksöz, F. D. Morgan

12.214 Environmental Geophysics
(Subject meets with 12.507)
Prereq: 18.03
U (Spring)
3-3-6
Meets with subject 12.507, but assignments differ.
F. D. Morgan

12.215 Modern Navigation
Prereq: None
U (Fall)
3-1-8
Introduces the concepts and applications of navigation techniques using celestial bodies and satellite positioning systems such as the Global Positioning System (GPS). Topics include astronomical observations, radio navigation systems, the relationship between conventional navigation results and those obtained from GPS, and the effects of the security systems, Selective Availability, and anti-spoofing on GPS results. Laboratory sessions cover the use of sextants, astronomical telescopes, and field use of GPS. Application areas covered include ship, automobile, and aircraft navigation and positioning, including very precise positioning applications.
T. A. Herring

12.221 Field Geophysics
Prereq: None
U (IAP)
1-4-1 [P/D/F]
Practical methods of modern geophysics including the Global Positioning System (GPS), gravity, and magnetics. Field work is conducted in western US and includes intensive 10-day field exercise. Focus is on measurement techniques and their interpretation. Introduction to the science of gravity, magnetics, and the GPS. Measure of crustal structure, fault motions, tectonic deformations, and the local gravity and magnetic fields. Students perform high-precision measurements and participate in data analysis. Emphasis on the principles of geophysical data collection and the relevance of these data for tectonic faulting, crustal structure, and the dynamics of the earthquake cycle.
T. A. Herring, B. H. Hager

12.222 Field Geophysics Analysis
Prereq: 12.221
U (Spring)
2-0-4
Focuses on in-depth data analysis and the development of the skills needed to report results both in writing and orally. In weekly meetings, students use data collected in 12.221 to develop written and oral reports of the results. Each student focuses on a different area of the results. For example, students can develop the geophysical modeling of the results or synthesis of the results into other studies in the area. The final written and oral reports from the students are structured so that they can be combined into a comprehensive report of the field camp and its results. A final oral presentation of results is required during the final few weeks of the spring term.
T. A. Herring, B. H. Hager

Atmospheres, Oceans, and Climate

12.300J Global Change Science
(Same subject as 1.071J)
Prereq: 18.03; 5.60
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
See description under subject 1.071J.
E. A. B. Eltahir

12.301 Past and Present Climate
(Subject meets with 12.842)
Prereq: Chemistry (GIR), 18.03, or permission of instructor
U (Fall)
4-0-8
Introduction to climate studies, including beginnings of the solar system, time scales, and climate in human history; methods for detecting climate change, including proxies, ice cores, instrumental records, and time series analysis; physical and chemical processes in climate, including primordial atmosphere, ozone chemistry, carbon and oxygen cycles, and heat and water budgets; internal feedback mechanisms, including ice, aerosols, water vapor, clouds, and ocean circulation; climate forcing, including orbital variations, volcanism, plate tectonics, and solar variability; climate models and mechanisms of variability, including energy balance, coupled models, and global ocean and atmosphere models; and outstanding problems. Students taking the graduate version complete different assignments.
C. Wunsch, E. Boyle, K. Emanuel
12.306 Atmospheric Physics and Chemistry  
(Subject meets with 10.571J, 12.806J)  
Prereq: 5.61, 18.075, or permission of instructor  
U (Spring)  
3-0-9  
Meets with subject 12.806J, but assignments differ. See description under subject 12.806J.  
R. G. Prinn, G. J. McRae

12.307 Weather and Climate Laboratory  
Prereq: Calculus II (GIR), Physics I (GIR)  
U (Spring)  
1-4-7 Institute LAB  
A laboratory subject intended to illustrate, by means of hands-on projects, the basic dynamical and physical principles which govern the general circulation of the atmosphere and the day-to-day sequence of weather events. Real-time meteorological observations are studied together with laboratory fluid experiments. Projects based on real-time observations stress the analysis and dynamical interpretation of the real phenomena, while complementary rotating tank experiments stress planning and testing of ideas in a more controlled laboratory environment. Written critical summaries of the results of each project and oral presentations are an integral part of the subject.  
R. A. Plumb

12.310 An Introduction to Weather Forecasting  
Prereq: Physics I (GIR), Calculus I (GIR)  
U (IAP)  
1-1-4 [P/D/F]  
Basic principles of synoptic meteorology and weather forecasting. Analysis of hourly weather data and numerical weather prediction models. Regular preparation of weather forecasts.  
L. Illari

12.320J Introduction to Hydrology  
(Same subject as 1.070J)  
Prereq: 1.060; Coreq: 1.061, 1.106  
U (Fall)  
3-0-9  
See description under subject 1.070J.  
D. Entekhabi

12.330J Fluid Physics  
(Same subject as 8.292J)  
Prereq: 8.044, 5.60, or permission of instructor  
U (Spring)  
3-0-9  
See description under subject 8.292J.  
P. Joss

12.333 Atmospheric and Ocean Circulations  
Prereq: 12.003  
U (Spring)  
3-0-9  
Survey of atmospheric and oceanic phenomena including the discussion of observations and theoretical interpretations. Topics covered include monsoons, El Niño, planetary waves, atmospheric synoptic eddies and fronts, gulf stream rings, hurricanes, surface and internal gravity waves, and tides.  
R. A. Plumb

12.335 Experimental Atmospheric Chemistry  
(Subject meets with 12.835)  
Prereq: Chemistry (GIR)  
2-4-6 Institute LAB  
Introduces the atmospheric chemistry involved in climate change, air pollution, and ozone depletion using a combination of interactive laboratory and field studies and simple computer models. Uses instruments for trace gas and aerosol measurements and methods for inferring fundamental information from these measurements. Undergraduate section provides instruction and practice in written and oral communication. Students taking the graduate version complete different assignments.  
R. Prinn

12.340 Global Warming Science (New)  
Prereq: Physics I (GIR), Calculus I (GIR), or permission of instructor; Coreq: 5.60  
U (Spring)  
3-0-9  
Provides students with a scientific foundation of anthropogenic climate change and an introduction to climate models. Focuses on fundamental physical processes that shape climate (e.g. solar variability, orbital mechanics, greenhouse gases, atmospheric and oceanic circulation, and volcanic and soil aerosols) and on evidence for past and present climate change. Discusses material consequences of climate change, including sea level change, variations in precipitation, vegetation, storminess, and the incidence of disease. Examines the science behind mitigation and adaptation proposals.  
K. Emanuel, S. Seager

12.348J Global Climate Change: Economics, Science, and Policy (New)  
(Same subject as 15.026J)  
(Subject meets with 12.848J, 15.023J, ESD.128J)  
Prereq: Calculus II (GIR), 5.60; 14.01 or 15.010; or permission of instructor  
U (Spring)  
3-0-6  
See description under subject 15.026J.  
H. D. Jacoby, R. G. Prinn

Planetary Science and Astronomy

12.400 The Solar System  
Prereq: Physics I (GIR)  
U (Spring)  
3-0-9 REST  
Introduction to the study of the solar system with emphasis on the latest spacecraft results. Subject covers basic principles rather than detailed mathematical and physical models. Topics include an overview of the solar system, planetary orbits, rings, planetary formation, meteorites, asteroids, comets, planetary surfaces and cratering, planetary interiors, planetary atmospheres, and life in the solar system.  
R. P. Binzel

12.402J Introduction to Astronomy  
(Same subject as 8.282J)  
Prereq: Physics I (GIR)  
U (Spring)  
3-0-6 REST  
See description under subject 8.282J.  
Staff

12.409 Hands-On Astronomy: Observing Stars and Planets  
Prereq: None  
U (Spring)  
0-4-2 [P/D/F]  
Background for and techniques of visual observation, electronic imaging, and spectroscopy of the Moon, planets, satellites, stars, and brighter deep-space objects. Weekly outdoor observing sessions using 8-inch diameter telescopes when weather permits. Indoor sessions introduce needed skills. Introduction to contemporary observational astronomy including astronomical computing, image and data processing, and how astronomers work. Student must maintain a careful and complete written log which is graded. Consumes an entire evening each week; 100% attendance at observing sessions required to pass. Enrollment limited; priority to freshmen.  
J. L. Elliot
12.410J Observational Techniques of Optical Astronomy
(Same subject as 8.287J)
Prereq: 8.282J, 12.402J, 12.409, or other introductory astronomy course; Coreq: 8.03
U (Fall)
3-4-8 Institute LAB

Fundamental physical and optical principles used for astronomical measurements at visible wavelengths and practical methods of astronomical observations. Topics: astronomical coordinates, time, optics, telescopes, photon counting, signal-to-noise ratios, data analysis (including least-squares model fitting), limitations imposed by the Earth’s atmosphere on optical observations, CCD detectors, photometry, spectroscopy, astrometry, and time variability. Project at Wallace Astrophysical Observatory. Written and oral project reports. Enrollment limited to 24; priority to Course 8 and Course 12 majors and minors.

J. L. Elliot

12.411I Astronomy Field Camp
Prereq: 12.410J or 8.287J
U (IAP)
0-6-3 [P/D/F]
Can be repeated for credit

Individual research projects in observational astronomy involving supervised work at Lowell Observatory (located in Flagstaff, AZ). Written and oral reports required. Enrollment limited to 6.

J. L. Elliot

12.420 Physics and Chemistry of the Solar System
Prereq: 8.03, 12.002 or permission of instructor
U (Spring)
3-0-9

Advanced applications of physical and chemical principles to the study of the solar system. Topics include terrestrial and giant planets, meteorites, asteroids, comets, Kuiper belt objects, rings, impact craters, interiors, surfaces, atmospheres, geomagnetism, cosmochemistry, remote sensing, formation and evolution of the solar system.

B. Weiss

12.425J Extrasolar Planets: Physics and Detection Techniques
Prereq: Physics I (GIR), Calculus I (GIR)
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
2-1-9 REST

Basic principles of planet atmospheres and interiors applied to the study of extrasolar planets. Focus on fundamental physical processes related to observable extrasolar planet properties. Quantitative overview of detection techniques. Introduction to the feasibility of the search for Earth-like planets, biosignatures and habitable conditions on extrasolar planets.

S. Seager

12.43J Space Systems Engineering (New)
(Same subject as 16.83J)
Prereq: Permission of department
U (Spring)
3-3-6

See description under subject 16.83J.

J. A. Hoffman, D. L. Miller, S. Seager

12.431J Space Systems Development I (New)
(Same subject as 16.831J)
Prereq: 16.83
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
2-6-4 1/2 Institute LAB

See description under subject 16.831J.

D. W. Miller, J. Keesee, S. Seager

12.432J Space Systems Development II (New)
(Same subject as 16.832J)
Prereq: 16.831
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
1-5-0 1/2 Institute LAB

See description under subject 16.832J.

D. W. Miller, J. Keesee, S. Seager

12.450 Seminar in Geology and Geochemistry
Prereq: Permission of instructor
G (Spring)
2-0-4 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Seminar on topics of current interest in geology and geochemistry. Required background preparation for students taking predoctoral general examinations in these subjects.

Geology and Geochemistry Staff

12.451 Seminar in Regional Tectonics
Prereq: Permission of instructor
G (Fall, Spring)
3-0-6 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Applies techniques of tectonic synthesis to study the roles of particular orogenic belts in global plate tectonics. Treats different applications in different terms, so that the subject may be taken repeatedly to learn the range of orogenic responses to temporal and spatial variations of activity at plate boundaries.

B. C. Burchfiel, L. H. Royden

12.452 Mechanics of Sedimentary Processes
(Subject meets with 12.111)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

See description under subject 12.111.

12.445 Written and Oral Communication in the Earth, Atmospheric, and Planetary Sciences
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit

Concentrated instruction and practice in professional writing and oral presentation within the context of the earth, atmospheric, and planetary sciences. Specifically designed to complement the SM degree program in Geosystems, but also ideal for other graduate students in Course 12 who wish to improve their communication skills. Topics include review of the many communication styles prevalent in the field; strategies for tailoring reports, technical papers, and presentations for specific audiences; and mechanics of organization and style. Weekly assignments in writing or speaking with peer and instructor feedback. Students are expected to develop and publicly defend a research proposal as part of the subject. For Geosystems students, this proposal anticipates the thesis required for completion of the SM degree program.

D. Morgan

Geology and Geochemistry

12.453–12.454 Crosby Lectures in Geology
Prereq: Permission of instructor
G (Fall, Spring)
3-0-6 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

A series of presentations on an advanced topic in the field of geology by the visiting William...
Otis Crosby lecturership. The Crosby lecturership is awarded to a distinguished international scientist each year to introduce new scientific perspectives to the MIT community. Subject content and structure vary from year to year. Consult Department Headquarters

12.455 Megascopic Strain Analysis in Orogenic Belts
Prereq: 12.113
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-6 H-LEVEL Grad Credit

Introduction to modern techniques used to estimate the magnitude of strain in orogenic belts. Emphasis on megascopic strain analysis. Includes methods of determining sense of shear in various structural settings; the construction of 2-D balanced structural sections; the construction of 3-D structural sections; and graphical reconstruction of 2-D and 3-D sections to pre-deformational configurations.

EAPS Staff

12.456 Seminar in Rock Mechanics
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Discussion of current research or advanced topics in continental tectonics, rock mechanics, or experimental structural geology.

B. Evans

12.457 Sedimentary Basins
Prereq: 18.03, 12.113
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-6 H-LEVEL Grad Credit

Formation and evolution of basin systems in continental crust (including passive continental margins, foredeep accretionary basins, back-arc type basins, intraplate rifts, etc.) are examined with regard to tectonic settings, structural and sedimentary features, and deep lithospheric processes. Case studies of several sedimentary basins of each type.

L. H. Royden

12.458 Molecular Biogeochemistry
Prereq: Basic knowledge of organic chemistry
G (Fall)
2-0-4 [P/D/F] H-LEVEL Grad Credit

Covers all aspects of molecular biosignatures from their pathways of lipid biosynthesis, the distribution patterns of lipid biosynthetic pathways with regard to phylogeny and physiology, isotopic contents, occurrence in modern organisms and environments, diagenetic pathways, analytical techniques and the occurrence of molecular fossils through the geological record. There are several instructor lectures for background but the main emphasis is on detailed analysis of the recent literature on chemical fossils.

R. Summons

12.459 Sedimentary and Surficial Geology Investigations
(Subject meets with 12.159)
Prereq: Permission of instructor
G (Spring)
3-6-3 H-LEVEL Grad Credit
Can be repeated for credit

In-depth examination of modern and ancient depositional systems, Earth-surface landforms, and surficial processes, utilizing concepts of process sedimentology and geomorphology, sequence stratigraphy, and sedimentary basin analysis.

D. Rothman

12.460–12.461 Special Problems in Geology-Geochronology
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Special investigations, special laboratory work, or special fieldwork in geology, petrology, mineralogy or geochemistry. 12.460 is letter-graded.

Geology and Geochemistry Staff

12.463 Geomorphology
(Subject meets with 12.163)
Prereq: 12.001, Physics I (GIR), Calculus I (GIR); or permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-3-6 H-LEVEL Grad Credit

See description under subject 12.163.

T. Perron

12.464 Seminar in Sedimentary Geology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit

Discussion of current research or advanced topics in sedimentary geology including, but not restricted to, sediment transport, interactions between sedimentation and stratigraphic architecture, sedimentary geochemistry, carbonate platform development, and paleontology.

EAPS Staff

12.465 Sedimentary Geology
(Subject meets with 12.110)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-3-6 H-LEVEL Grad Credit

See description under subject 12.110.

EAPS Staff

12.467 Seminar in Geomorphology
Prereq: Permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit

Discussion of current research or advanced topics in landscape evolution, surface hydrology, mechanics of sediment transport, basin analysis, or experimental geomorphology. Advanced instruction in process geomorphology.

EAPS Staff

12.470 Essentials of Geology
Prereq: Physics II (GIR), Calculus II (GIR); or permission of instructor
G (Spring)
4-0-8

Geology of planetary interiors and surfaces, including plate tectonics, as a unifying theory of terrestrial geology, surface processes, and the Earth’s interior. Igneous, metamorphic, and sedimentary processes associated with tectonic settings and the typical rock suites created. Mineral and rock identification. Causes of compositional differences on many scales: mineral grains, rocks, regions of the Earth, different planets. Conditions required for melting and melting processes, Rock structure and field techniques. Earth history. Treatment of these topics include discussions of the geochemical, petrologic, geochronological, experimental, or field techniques used to investigate them; the limitations of current geological techniques and geological controversies; and great geological expeditions, experiments, and studies from the past, their premises, and their results.

L. Elkins-Tanton

12.472 Building Earth-like Planets: From Nebular Gas to Ocean Worlds
Prereq: Physics II (GIR), Calculus II (GIR); or permission of instructor
G (Fall)
3-0-9

Examination of the state of knowledge of planetary formation, beginning with planetary nebulae and continuing through accretion (from gas, to dust, to planetesimals, to planetary embryos, to planets). Processes of planetary differentiation,
crust formation, atmospheric degassing, and surface water condensation. Integrated discussions of compositional and physical processes, based upon observations from our solar system and from exoplanets. Focus on terrestrial (rocky and metallic) planets, though more volatile-rich bodies are also examined. Includes regular readings from literature, lectures, discussion, and problem solving.

L. Elkins-Tanton

12.474 Origin and Evolution of the Earth’s Crust
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit

Broad overview of the origin and evolution of Earth’s crust and mantle with emphasis on the study of the Precambrian rock record. Topics include: processes of crustal growth, stabilization, and reactivation; evaluation of secular change; and use of radiogenic isotopes in geochronology and as tracers of crust forming processes.

S. Bowring, S. Rondenay

12.475 Plate Tectonics and Continental Deformation
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-6 H-LEVEL Grad Credit

First half covers basic elements of plate tectonics, including sea floor spreading, magnetic anomalies, and subduction zone. Second half covers implications of plate tectonics for continental processes, including continental rifting, continental collision, and mountain building. Emphasis will be on correlating plate tectonic and continental processes using specific examples from around the world.

B. C. Burchfiel, L. H. Royden

12.476 Radiogenic Isotope Geology
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-3-6 H-LEVEL Grad Credit

Applications of the variations in the relative abundance of radiogenic isotopes to problems of petrology, geochemistry, and tectonics. Topics: geochronology; isotopic evolution of earth’s crust and mantle; petrogenesis; and analytical techniques.

S. Bowring

12.477 Tectonic Geomorphology and Low Temperature Thermochronology
Prereq: 18.03, 12.463, Coreq: 12.476
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-3-6 H-LEVEL Grad Credit

Advanced topics in the study of the interactions among climate-driven surface processes, surface topography, heat transport, and rock deformation in the evolution of orogenic systems. The geomorphic component emphasizes (1) critical problems in understanding river incision into bedrock, which governs the relation between topographic form (relief, mean elevation) and the rates and patterns of erosion, and (2) the nature and strength of feedbacks between erosion and deformation. The thermochronometry component emphasizes the co-evolution of the thermal field with topography and denudation rate, and outlines quantitative methods for, and limitations of, use of low temperature thermochronology (40Ar/39Ar, Fission Tracks, and (U-Th)/He) for discovering the history of topographic relief and denudation rate.

EAPS Staff

12.478 Pressure-Temperature-Time Evolution of Orogenic Belts
Prereq: 3.01 or 5.60; 12.109, 18.03
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit

Multidisciplinary introduction to modern techniques used to analyze burial and uplift histories of metamorphic terrains. Includes: geochronologic systems; closure temperature theory and the use of geochronologic systems as thermochronometers; geothermometry and geobarometry; thermodynamic modeling of P-T paths; thermal structure of orogenic belts, with emphasis on characteristic length scales and time scales for thermal events; and geophysical analysis of burial and uplift trajectories for metamorphic terrains.

L. H. Royden

12.479 Trace-Element Geochemistry
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Focuses on element distribution in rocks and minerals using data obtained from natural and experimental systems. Emphasizes models describing trace-element partitioning and applications of trace-element geochemistry to problems in igneous geology.

F. A. Frey

12.480 Thermodynamics for Geoscientists
Prereq: 5.60 or 3.00
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-3-6 H-LEVEL Grad Credit

Principles of thermodynamics are used to infer the physical conditions of formation and modification of igneous and metamorphic rocks. Includes phase equilibria of homogeneous and heterogeneous systems and thermodynamic modeling of non-ideal crystalline solutions. Surveys the processes that lead to the formation of metamorphic and igneous rocks in the major tectonic environments in the Earth’s crust and mantle.

T. L. Grove

12.481 Advanced Field Geology I
Prereq: 12.108, 12.113, 12.114, 12.115
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
2-2-2 H-LEVEL Grad Credit
Can be repeated for credit

Introduction to the problems to be investigated in 12.482, as well as the regional setting and local geology of the field area. Various special techniques may be introduced and preparatory investigations may be conducted that are specific to the area to be studied in 12.482.

B. C. Burchfiel

12.482 Advanced Field Geology II
Prereq: 12.481
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

In January, a geological and geomorphological study of a selected field area is conducted during a four-week excursion. The following term includes: preparation of maps and report based on field study conducted in January; and laboratory analysis of samples.

B. C. Burchfiel

12.484 Directed Field Studies
Prereq: Permission of instructor
G (IAP)
0-6-0
Can be repeated for credit

Intensive training in field geological methods. Includes specific exercises selected to complement the backgrounds of the students enrolled and provides supervised experience in applying field analytical techniques to geological problems. Cannot be taken as a substitute for 12.115. Preference will be given to students
12.485 Advanced Directed Field Studies
Prereq: 12.484
G (IAP)
0-6-0
Can be repeated for credit
Continuation of 12.484. Designed to provide more advanced training in specific field geological methods. Can be taken during the same IAP period as 12.484. Preference will be given to students associated with Course 12. Enrollment limited; students should apply early.

12.486 Advanced Igneous Petrology (New)
Prereq: Permission of instructor
G (Fall)
3-2-7 H-LEVEL Grad Credit
Can be repeated for credit
Comprehensive overview of igneous rocks from the Earth, Moon, and meteorite parent bodies. Discusses the compositional diversity of igneous rocks and how it can be used to elucidate rock forming processes in the major tectonic provinces on modern Earth, including mid-ocean ridges, subduction zones, ocean islands, and inter-continental rifting environments. Also covers magma generation processes in the terrestrial planets prior to 2.6 billion years ago. Laboratory exercises on selected suites of igneous rocks reinforce readings and classroom discussions. Uses evidence from related geoscience disciplines to develop an integrative approach to understanding processes that lead to the chemical differentiation of planetary bodies through time. Subject matter may be modified to reflect the interests of the group.
T. L. Grove

12.488–12.489 Special Problems in Structural Geology
Prereq: None
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Special investigations, special laboratory work, or special fieldwork in structural geology.

Geology and Geochemistry Staff

12.490–12.491 Advanced Seminar in Geology and Geochemistry
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Problems of current interest in geology and geochemistry. Subject matter varies from term to term. 12.490 is letter-graded.

Geology and Geochemistry Staff

Geophysics

12.501 Essentials of Geophysics
(Same subject meets with 12.201)
Prereq: Physics II (GIR), 18.03
G (Fall)
4-0-8 H-LEVEL Grad Credit
Overview of basic topics in solid-earth geophysics, such as the Earth’s rotation, gravity and magnetic field, seismology, and thermal structure. Formulation of physical principles presented in three one-hour lectures per week. Current applications discussed in an additional one-hour tutorial each week.
R. D. van der Hilst

12.507 Environmental Geophysics
(Same subject meets with 12.214)
Prereq: 18.03
G (Spring)
3-3-6
Introduction to basic geophysical methods that can be used for environmental site characterization and shallow geological investigations. Techniques include seismic, electrical, and electromagnetic sounding; ground-penetrating radar, magnetics, gravity, and borehole geophysics. Lectures emphasize basic principles and a physical understanding of the geophysical methods with environmental and engineering applications in mind. Some specific case histories are included. A few weekends of field measurements at representative local sites are included. Lab sessions cover modeling and interpretation of geophysical field data.
F. D. Morgan

12.510 Introduction to Seismology
Prereq: 18.075 or 18.085
G (Spring)
3-1-8 H-LEVEL Grad Credit
A basic study in seismology and the utilization of seismic waves for the study of Earth’s interior. Introduces techniques necessary for understanding of elastic wave propagation in stratified media and for calculation of synthetic seismograms (WKB and mode summation). Ray theory; interpretation of travel times. (e.g., tomography); surface wave dispersion in layered media; Earth’s free oscillations; and seismicity, (earthquake locations, magnitude, moment, and source properties).
R. D. van der Hilst

12.515 Data and Models
Prereq: 18.075 or 18.085
G (Fall)
3-0-9 H-LEVEL Grad Credit
Surveys a number of methods of inverting data to obtain model parameter estimates. Topics include review of matrix theory and statistics, random and grid-search methods, linear and non-linear least squares, maximum-likelihood estimation, ridge regression, stochastic inversion, sequential estimation, singular value decomposition, solution of large systems, genetic and simulated annealing inversion, regularization, parameter error estimates, and solution uniqueness and resolution. Computer laboratory and algorithm development.
F. D. Morgan

12.518 Sonar, Radar, and Seismic Signal Processing
(Same subject as 2.686J, 6.455J)
Prereq: 2.004 or 6.003; 6.041; 18.075 or 18.085
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.686J.
N. C. Makris, J. C. Preisig, Woods Hole Staff

12.520 Geodynamics
Prereq: 12.005; 18.075 or 18.085
G (Fall)
3-0-9 H-LEVEL Grad Credit
Mechanics of deformation of the crust and mantle, with emphasis on the importance of different rheological descriptions: brittle, elastic, linear and nonlinear fluids, and viscoelastic.
B. H. Hager

12.521 Computational Geodynamics Modeling
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-6 H-LEVEL Grad Credit
An introduction to theory, design, and practical methods of computational modeling in geodynamics. Covers the most effective and widely used numerical modeling approaches and emphasizes problem-solving skills through illustrative examples of heat and mass transfer.
12.522 Geological Fluid Mechanics
Prereq: 8.03; 18.076 or 18.085
G (Fall)
3-0-9 H-LEVEL Grad Credit
Treats heat transfer and fluid mechanics in the Earth, low Reynolds number flows, convection instability, double diffusion, Non-Newtonian flows, flow in porous media, and the interaction of flows with accreting and deforming boundaries. Applications include: the flow under plates, postglacial rebound, diapirism, magma dynamics, and the mantle convection problem.
J. A. Whitehead (WHOI)

12.524 Mechanical Properties of Rocks
Prereq: 8.03, 18.03
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
A survey of the mechanical behavior of rocks in natural geologic situations. Topics: brief survey of field evidence of rock deformation, physics of plastic deformation in minerals, brittle fracture and sliding, and pressure-solution processes. Results of field petrologic and structural studies compared to data from experimental structural geology.
B. Evans

12.525 Mechanisms of Faulting and Earthquakes
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Explores the fundamental mechanisms of faulting and earthquakes from four related perspectives: seismology, geodesy, geodynamics, and rheology. Topics to be covered include (1) the physical processes that control the rheology of faults, including friction and fracture, (2) how these rheological processes are manifest in faulting and earthquakes in the earth from a geodynamics perspective, and (3) how the mechanics of faulting and earthquakes are constrained by seismological and geodetic observations. Both continental and oceanic examples of faulting and earthquakes will be featured.
J. Lin, G. Hirth, J. McGuire

12.533 Rock Physics
Prereq: Permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit
Fundamentals of experimental and theoretical rock physics taught at an advanced level. Rocks viewed as complex composite media with behavior dependent both on the physical and chemical properties of the constituent phases, and on their geometries. Electrical, fluid transport, and seismic properties covered in detail. Other topics such as magnetic, mechanical, and thermal responses briefly discussed. Weekly laboratory.
F. D. Morgan

12.540 Principles of Global Positioning System
Prereq: Physics I (GIR), Calculus II (GIR), 18.06
Acad Year 2009–2010: Not offered
3-1-8 H-LEVEL Grad Credit
The principles and applications of the Global Positioning System (GPS) and other space geodetic systems, including very-long-baseline interferometry (VLBI) and satellite laser ranging (SLR). The nature and uses of the course acquisition (CA), the precise positioning (P) codes, and the differential carrier phase observable. Techniques for estimating geodetic and geophysical quantities from these data. Other topics include: atmospheric refraction modeling, effects of Selective Availability (SA), estimation techniques (including Kalman filtering). Statistical and spectral analysis of data.
T. A. Herring

12.552 Advanced Seismology: Theory and Applications of Seismic Imaging
Prereq: 12.510
G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduces fundamental principles of seismic imaging used in both exploration and solid earth applications. Topics include ray theoretical approaches, scattering theory, and seismic waveform modeling. Through lectures, projects and student-led discussions of journal articles, the class covers the whole process of seismic imaging, from data preprocessing to model generation and geological interpretation of the results.
S. Rondenay and A. Malcolm

12.560–12.561 Special Seminar in Exploration Geophysics
Prereq: Permission of instructor
G (Fall, IAP, Spring)
2-0-4 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Advanced seminar focusing on areas of current interest in exploration geophysics and seismology. Taught by visiting lecturers. 12.560 is letter-graded.
Geophysics Staff

12.570 Topical Issues in Global Geophysics
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Series of formal lectures and seminars with the specific content varying by term to reflect current issues in research. Meets jointly with relevant Harvard course.
R. D. van der Hilst

12.571 Seminar in Geophysics
Prereq: Permission of instructor
Acad Year 2009–2010: None
Acad Year 2010–2011: G (Fall)
3-0-9
Develops knowledge of the materials that constitute the Earth and planetary interiors and are fundamental to understanding the structures and dynamics of the planets. Discusses crystal structures, elastic and thermodynamic properties, equations of state, chemical reactions, and phase relations of materials at the mantle and the core. Instruction on use of laboratory or theoretical mineral physics data for the interpretation of seismic observations and the construction of dynamic models for the Earth and planetary interiors.
S.-H. Shim

12.580–12.581 Special Problems in Geophysics
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Special investigations, special laboratory work, or special fieldwork in geophysics. 12.580 is letter-graded.
Geophysics Staff
Planetary Science

12.601 Essentials of Planetary Science
Prereq: 8.03, 18.03
G (Spring)
3-0-9 H-LEVEL Grad Credit

Reviews fundamental physical concepts pertaining to the study of the solar system, and highlights recent spacecraft results. Topics include: meteorites, orbital dynamics, asteroids, impact craters, surfaces, atmospheres, atmospheric dynamics, interiors, magnetospheres, rings, comets, formation of the solar system.

B. Weiss

12.602 Asteroids and Small Bodies
Prereq: Physics II (GIR), 18.03
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Introduction to the study of asteroids and the ground-based and space-based techniques used to explore them. Topics include asteroid orbital properties, surface structure, physical properties, classifications, as well as their origin, thermal and collisional evolution, and interrelationships with meteorites and comets. Subject also covers the near-earth asteroids, the probabilities and consequences of terrestrial collisions, and the possible utilization of asteroids as space resources.

R. P. Binzel

12.603 Solar System Dynamics
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Can be repeated for credit

Introduction to chaotic behavior in conservative systems, with examples drawn primarily from the rotation and orbital dynamics of planets and satellites. Includes surfaces of section, Lyapunov exponents, perturbation theory, KAM theorem, resonances, onset of chaos, double pendulum, Henon-Heiles problem, restricted three-body problem, spin-orbit coupling, orbital resonances, adiabatic invariants, adiabatic chaos, tidal evolution, capture into resonance, and stability of the solar system.

J. Wisdom

12.611 Advanced Planetary Observations
Prereq: Permission of instructor
G (IAP)
0-6-3 [P/D/F] H-LEVEL Grad Credit

Astronomical observations involving several techniques are carried out at a major observatory, with focus on a particular set of objectives that change from year to year. Work includes: critical planning of the observations; acquiring the data; calibrating the data; and on-site data reduction.

J. L. Elliot

12.616 Occultations, Eclipses, and Transits
Prereq: 8.03, 18.03 or 18.034
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Basic principles underlying occultation, eclipse, and transit phenomena, by solar system bodies and extra-solar planets, as observed throughout the electromagnetic spectrum from spacecraft and Earth-based platforms. Methods for predicting the times and locations where these phenomena will be visible and the techniques used for their observation. Data interpretation through physical modeling of the interaction (including gravitational lensing) of electromagnetic radiation with planetary limbs, rings, and atmospheres.

J. L. Elliot

12.620J Classical Mechanics: A Computational Approach
(Same subject as 6.946J, 8.351J)
(Subject meets with 12.008)
Prereq: Physics I (GIR), 18.03, permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit


J. Wisdom, G. J. Sussman

12.625 Topics in Exoplanets
Prereq: 8.03, 18.03
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9

In-depth study of current topics in exoplanets, such as exoplanet transits, radial velocity curves, current survey missions, the mass-radius relation, and super Earths. Class activities consist of reading the current literature, problem sets, and a term project.

S. Seager, J. L. Elliot

12.650 Current Topics in Planetary Science
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit

In-depth discussion of current and classic literature on selected topics in planetary science. Topics vary from year to year.

J. Wisdom

12.690–12.691 Special Problems in Planetary Science
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Special investigations, special laboratory work, or special fieldwork in planetary science. 12.690 is letter-graded.

Planetary Science Staff

Geological, Geophysical, and Chemical Oceanography

12.707 Pre-Pleistocene Paleooceanography and Paleoeclimatology
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Climate history of the Earth from the formation of the early atmosphere and ocean to the present. Evaluation of geochemical, sedimentological, and paleontological evidence for changes in ocean circulation, global temperatures, and atmospheric carbon dioxide levels. Theories and models of Phanerzoic climate change. Long-term history of the global carbon cycle.

WHOI staff
12.708 Special Topics in Paleoclimatology
Prereq: Permission of instructor
G (Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Advanced seminar focusing on areas of current interest in paleoceanography and paleoclimatology. Includes discussion of current and classic literature. Topics vary from year to year. D. Oppo, J. McManus, O. Marchal (WHOI)

12.710 Marine Geology and Geophysics I
Prereq: Permission of instructor
G (Fall)
3-2-7 H-LEVEL Grad Credit
An introduction to marine geology and geophysics suitable for any student interested in the ocean sciences. Also intended as part of a two-term sequence for first-year MIT-WHOI Joint Program students in marine geology and geophysics (MG&G). Topics include: deposition and preservation of marine sediments, climate proxies, Cenozoic to Holocene climate history, paleoceanography, marine stratigraphy and geochronology, structure of the earth, structure of oceanic crust, evolution of the oceanic lithosphere, mantle geodynamics, plate tectonics, ocean altimetry, and coastal sediment processes. J. McManus, R. Reves-Sohn, K. Sims

12.711 Marine Geology and Geophysics II
Prereq: 12.710
G (Spring)
3-2-7 H-LEVEL Grad Credit
An introduction to marine geology and geophysics designed as part of a two-term sequence for first-year MIT-WHOI Joint Program students in marine geology and geophysics. Topics include: lithosphere evolution and mantle dynamics, the structure and composition of the oceanic crust and mantle, tectonic and magmatic processes at mid-ocean ridges, hotspot volcanism, subduction and arc magmatism, and the crustal structure and sedimentation history of continental margins. N. Shimizu, D. Smith, S. Humphris

12.712 Advanced Marine Seismology
Prereq: 12.710/12.711
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit
Focuses on synthetic seismograms, ocean bottom reflection seismology, and multi-channel reflection seismology as applied to studies of the ocean sediments, crust, and lithosphere. Topics include: the wave equations for elastic/anelastic, isotropic/anisotropic, homogeneous/heterogeneous and fluid/solid media; ray theory and WKBJ approximations; the Sommerfeld/Weyl integrals, asymptotic analysis, and Lamb’s problem for a fluid/solid interface; reflectivity and related methods; finite difference and finite element methods; and special topics of interest to the class. Extensive readings of geophysical and seismological literature. R. Stephen (WHOI)

12.714 Computational Data Analysis
Prereq: 18.03
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
An introduction to the theory and practice of analyzing discrete data such as are normally encountered in geophysics and geology. Emphasizes statistical aspects of data interpretation and the nonparametric discrete-time approach to spectral analysis. Topics include: elements of probability and statistics, statistical inference, robust and nonparametric statistics, the method of least squares, univariate and multivariate spectral analysis, digital filters, and aspects of multidimensional data analysis. A. D. Chave, R. Sohn

12.716 Igneous Processes at Oceanic Margins
Prereq: 12.710, 12.711, or permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-2-4 H-LEVEL Grad Credit
Can be repeated for credit
Quantitative analysis of melting, melt transport, and igneous crustal accretion at ocean spreading centers, rifted continental margins, and subduction-related arcs, applied to understanding variation in composition and volume of the Earth’s crust in different tectonic environments. Theoretical methods for calculation of melt volume and composition, solid-liquid equilibria and reaction rates, and liquid density and viscosity combined with field, petrographic, geochemical, and computational techniques. Topics vary from year to year. H. Dick, G. Gaetani (WHOI)

12.718 Kinetics and Mass Transport
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit
Offers a broad overview of various kinetic and transport processes in geology, including volume and grain boundary solid-state diffusion, defects in minerals, rates of mineral reaction and transformation, crystal nucleation and growth, advective transport in porous media and partially molten aggregates, and percolation theory. Emphasis on processes in crystalline rocks. Covers theoretical, phenomenological, and experimental constraints, with a consistent application to “real-world” settings and actual case histories. G. Hirth, S. Hart (WHOI)

12.721 Special Problems in Marine Geology and Geophysics at Woods Hole
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Special investigations, special laboratory work, or special fieldwork in marine geology and geophysics. WHOI Staff

12.722 Special Problems in Chemical Oceanography at Woods Hole
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
For graduate students desiring to perform special investigations, special laboratory work, or special fieldwork in chemical oceanography. WHOI Staff

12.730–12.731 Special Problems in Marine Geology and Geophysics at MIT
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
For students in the MIT/WHOI Joint Program desiring to perform special investigations, special laboratory work, or special fieldwork in marine geology and geophysics under the supervision of a faculty member in residence at MIT. 12.730 is letter-graded. Marine Geology and Geophysics Staff

12.735–12.736 Special Problems in Chemical Oceanography at MIT
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
For students in the MIT/WHOI Joint Program desiring to perform special investigations, special laboratory work, or special fieldwork in chemical oceanography under the supervision of
a faculty member in residence at MIT. 12.735 is letter-graded.

Chemical Oceanography Staff

12.740 Paleooceanography
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

The history of the earth-surface environment is deduced from the records preserved in deep-sea sediments, ice cores, and corals. Micropaleontological, isotopic, geochemical, and mineralogical changes are used to infer changes in seawater composition, atmospheric chemistry, and climate. These observations are interpreted as consequences of changes in ocean temperature, circulation, and chemistry and used to evaluate theories proposed to account for glacial/interglacial cycles (e.g. orbital forcing). The past 2 million years are emphasized, but major processes and events from the past 100 million years are included.

E. A. Boyle

12.742 Marine Chemistry
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

An introduction to chemical oceanography. Reservoir models and residence time. Major ion composition of seawater. Inputs to and outputs from the ocean via rivers, the atmosphere, and the sea floor. Biogeochemical cycling within the oceanic water column and sediments, emphasizing the roles played by the formation, transport, and alteration of oceanic particles and the effects that these processes have on seawater composition. Cycles of carbon, nitrogen, phosphorus, oxygen, and sulfur. Uptake of anthropogenic carbon dioxide by the ocean. Material presented through lectures and student-led presentation and discussion of recent papers.

S. Doney, W. Martin, K. Casciotti, M. K. Tivey (WHOI)

12.743 Geochemistry of Marine Sediments
Prereq: Chemistry (GIR), 5.60
G (Fall)
3-0-9 H-LEVEL Grad Credit


D. McCorkle, W. Martin (WHOI)

12.744 Marine Isotope Chemistry
Prereq: 12.748 or permission of the instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
2-0-4 H-LEVEL Grad Credit

Focuses on isotope systematics applied to important problems in marine chemistry, specifically isotope systematics of light stable isotopes and intermediate mass stable isotope systematics.

W. Jenkins, J. Hayes (WHOI)

12.745 Ore Deposition at Submarine Ridge Axes
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit


Staff

12.746 Marine Organic Geochemistry
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

Provides an understanding of the distribution of organic carbon (OC) in marine sediments from a global and molecular-level perspective. Surveys the mineralization and preservation of OC in the water column and within anoxic and oxic marine sediments. Topics include: OC composition, reactivity and budgets within, and fluxes through, major reservoirs; microbial recycling pathways for OC; models for OC degradation and preservation; role of anoxia in OC burial; relationships between dissolved and particulate (sinking and suspended) OC; methods for characterization of sedimentary organic matter; application of biological markers as tools in oceanography. Both structural and isotopic aspects are covered.

D. Repeta, T. I. Eglinton (WHOI)

12.747 Modeling, Data Analysis, and Numerical Techniques for Geochemistry
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Emphasizes the basic skills needed for handling and assimilating data as well as the basic tool-set for numerical modeling. Uses MATLAB as its computation engine; begins with an introduction to MATLAB to ensure familiarity with software. Topics include: probability distributions, error propagation, least squares and regression techniques, principle component and factor analysis, objective mapping, Fourier and spectral analysis, numerical solutions to ODEs and PDEs, finite difference techniques, inverse models, and scientific visualization.

D. Glover, W. Jenkins, S. Doney (WHOI)

12.748 Introduction to Isotope Chemistry
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit

Teaches fundamental aspects of isotope chemistry applied to the ongoing evolution of Earth and its major geochemical reservoirs (core, mantle, oceanic and continental crusts, seawater) in the context of solar system evolution. The course introduces students to nuclear physics, nucleosynthesis, mass spectrometry, isotope fractionation processes and the application of important isotope groups to fundamental processes in Earth’s chemical evolution.

W. Jenkins, J. Hayes, K. Sims (WHOI)

12.749 Solid Earth Geochemistry
Prereq: 12.748 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
2-0-4 H-LEVEL Grad Credit

Uses the isotopic methods and tools developed in 12.748, in conjunction with major and trace element systematics to examine in detail the fundamental processes of solid Earth accretion and differentiation. Introduces concepts of nebular condensation, meteorites and their parent bodies, origin and evolution of the moon, planetary differentiation, formation and evolution of the Earth’s mantle and crust, and magmatism in ocean basins.

K. Sims, G. Gaetani (WHOI)
12.751–12.759 Seminar in Oceanography at Woods Hole
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Topics in marine geology and geophysics, physical, dynamical, and chemical oceanography. Content varies from term to term. 12.754, 12.755, and 12.756 are letter-graded.
WHOI Staff

12.760–12.761 Seminar in Marine Geology and Geophysics at MIT
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Topics in marine geology and geophysics taught at MIT. Content varies from term to term. 12.760 is letter-graded.
Marine Geology and Geophysics Staff

12.770–12.771 Seminar in Chemical Oceanography at MIT
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Topics in chemical oceanography taught at MIT. Content varies from term to term. 12.770 is letter-graded.
Chemical Oceanography Staff

Atmospheres, Oceans, and Climate

12.800 Fluid Dynamics of the Atmosphere and Ocean
Prereq: 8.03, 18.04
G (Fall)
3-0-9 H-LEVEL Grad Credit
J. Pedlosky (WHOI)

12.801 The General Circulation of the Ocean
Prereq: 12.800
G (Spring)
3-0-9 H-LEVEL Grad Credit
Fundamental principles of geophysical fluid dynamics are applied to the ocean to understand and describe its global circulation patterns. Includes geostrophic dynamics, planetary geostrophy, Ekman pumping, wind and thermally driven ocean circulation, thermocline theory, western boundary current dynamics, abyssal circulation, mixing, dynamics of circumpolar jets, baroclinic instability, geostrophic turbulence, eddy-mean flow interaction.
J. Marshall

12.802 Wave Motions in the Ocean and Atmosphere
Prereq: 12.800
G (Spring)
3-0-9 H-LEVEL Grad Credit
Basic ideas of geophysical wave motion in rotating, stratified, and rotating-stratified fluids. Subject begins with general wave concepts of phase and group velocity. The dynamics and kinematics of gravity waves with a focus on dispersion, energy flux, initial value problems, etc. Subject foundation used to study internal and inertial waves, Kelvin, Poincare, and Rossby waves in homogeneous and stratified fluids. Laplace tidal equations are applied to equatorial waves. Other topics include: resonant interactions, potential vorticity, wave-mean flow interactions, and instability.
P. Rizzoli

12.803 Quasi-balanced Circulations in Oceans and Atmospheres
Prereq: 12.800, Coreq: 12.804
G (Fall)
3-0-9 H-LEVEL Grad Credit
Dynamics of large-scale circulations in oceans and atmospheres, taken concurrently with the laboratory subject 12.804. Basic concepts include mass and momentum conservation, hydrostatic and geostrophic balance, and pressure and other vertical coordinates. Barotropic vorticity equation: potential vorticity (PV) and invertibility; Greens functions/point vortices; balance in forced flow, waves, and vortices. Shallow water equations, geostrophic adjustment. Stratified atmospheres and oceans: thermodynamics. The quasi-geostrophic (QG) equations, pseudo potential vorticity, Barotropic and baroclinic instabilities and the Rayleigh, Fjortoft and Chanrey-Stern theorems. Eady and Charney models. The superposition theorem and the continuous spectrum. Effects of boundary friction, upward wave radiation, and phase change of water. Frontogenesis and semigeostrophy.
K. A. Emanuel

12.804 Large-scale Flow Dynamics Laboratory
Prereq: 12.800, Coreq: 12.803
G (Fall)
0-3-6 H-LEVEL Grad Credit
Laboratory component of subject 12.803. Analysis of observations of oceanic and atmospheric quasi-balanced flows, computational models, and rotating tank experiments. Illustrates the basic principles of potential vorticity conservation and inversion, Rossby wave propagation, baroclinic instability, and the behavior of isolated vortices.
L. Illari, G. Flierl

12.805 Laboratory in Physical Oceanography
Prereq: 12.808
G (Spring)
2-2-5 H-LEVEL Grad Credit
An introduction to standard data analysis methods including time series analysis, objective mapping, empirical orthogonal functions, and dynamic analysis of hydrographic data. Emphasis on working with data in a computer laboratory setting using packaged software. Where appropriate, comparison is made with simple models. Some attention given to the instruments and algorithms used to acquire the data.
WHOI Staff

12.806 Atmospheric Physics and Chemistry
(Same subject as 10.571J)
(Subject meets with 12.306)
Prereq: 5.61, 18.075, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduction to the physics and chemistry of the atmosphere including experience with computer codes. Aerosols and theories of their formation, evolution, and removal. Gas and aerosol transport from urban to continental scales. Coupled models of radiation, transport, and chemistry. Solution of inverse problems to deduce emissions and removal rates. Emissions control technology and costs. Applications to air pollution and climate.
R. G. Prinn, G. J. McRae

12.807 Atmospheric Chemistry
Prereq: 5.60
G (Fall)
3-0-9 H-LEVEL Grad Credit
Describes the principles that govern the chemical behavior of terrestrial and planetary atmospheres. Reviews chemical reactions
and biogeochemical cycles that control the abundance of trace species in the troposphere and stratosphere. Emphasis is placed on the potentially damaging effects of human activity on the chemical balance of the atmosphere. Covers stratospheric ozone depletion, regional and local photochemical smog, and greenhouse gases.

Staff

12.808 Introduction to Observational Physical Oceanography
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

Results and techniques of observations of the ocean in the context of its physical properties and dynamical constraints. Emphasis on large-scale steady circulation and the time-dependent processes that contribute to it. Includes the physical setting of the ocean, atmospheric forcing, application of conservation laws, description of wind-driven and thermohaline circulation, eddy processes, and interpretive techniques.

J. Price (WHOI)

12.809 Hydraulic Phenomena in Geophysical Fluid Flows
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit

Examination of the hydraulics of nonrotating flows (Long’s experiments, hydraulic control, upstream influence, nonlinear wave steepening, hydraulic jump and bores, application to severe downslope winds). Other topics may include: nonrotating stratified flows (two-layer hydraulics, virtual and approach controls, maximal and submaximal flow, application to the Strait of Gibraltar and the Bab al Mandab); and deep ocean straits and sills (steady theories for rotating channel flow, nonlinear Kelvin and frontal waves, rotating hydraulic jumps, geostrophic adjustment in a rotating channel, and applications to the Denmark Strait and other deep passages).

L. Pratt (WHOI)

12.810 Dynamics of the Atmosphere
Prereq: 12.800
G (Spring)
3-0-9 H-LEVEL Grad Credit

Review of equations of motion. Zonally averaged budgets of heat, momentum, and water vapor. Review of historical understanding of the maintenance of zonal winds. Symmetric models of the general circulation. Introduction to waves and eddies in nonrotating and rotating fluids: specifically internal gravity waves, tides, Rossby waves, barotropic and baroclinic instabilities. The interaction of these asymmetric components of atmospheric motion with the zonally averaged circulation discussed. Emphasis on specific observed phenomena.

R. A. Plumb

12.811 Tropical Meteorology
Prereq: 12.810 or Coreq: 12.803
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

A description of the large-scale circulation systems of the tropical atmosphere and analysis of the dynamics of such systems. Topics include: Radiative-convective equilibrium; the Hadley and walker circulation; monsoons; tropical boundary layers; theory of the response of the tropical atmosphere to localized sea-surface temperature anomalies; intraseasonal oscillations; equatorial waves; El Niño/Southern Oscillation; easterly waves; and tropical cyclones.

K. A. Emanuel

12.812 General Circulation of the Earth’s Atmosphere
Prereq: 12.810 or Coreq: 12.803
G (Fall)
3-0-9 H-LEVEL Grad Credit

Diagnostic studies and discussion of their implications for the theory of the structure and general circulation of the Earth’s atmosphere. Includes some discussion of the validation and use of general circulation models as atmospheric analogs.

EAPS staff

12.815 Atmospheric Radiation
(Subject meets with 12.816)
Prereq: 5.61, 18.075, or permission of instructor
G (Fall)
2-2-2 H-LEVEL Grad Credit

Introduction to the physics of atmospheric radiation and remote sensing, including use of computer codes. Radiative transfer equation including emission and scattering, spectroscopy, Mie theory, and numerical solutions. Solution of inverse problems in remote sensing of atmospheric temperature and composition.

S. Seager, R. A. McClatchey

12.816 Atmospheric Radiation: Independent Study
(Subject meets with 12.815)
Prereq: 5.61, 18.075 or permission of the instructor
G (Fall)
2-2-5 H-LEVEL Grad Credit

Lecture content is the same as 12.815, but it is augmented by the development of an independent student project with associated term paper.

S. Seager

12.818 Introduction to Atmospheric Data and Synoptic Meteorology
Prereq: None. Coreq: 12.800
G (Fall)
3-3-6 H-LEVEL Grad Credit

Provides a general introduction to meteorological data and analysis techniques, and their use in the MIT Synoptic Laboratory to study the phenomenology and dynamics of large-scale atmospheric flow. Balance concepts as applied to the dynamics of frontal and synoptic scales are illustrated using real-time upper air and surface station data and gridded analyzed fields. Advanced meteorological software packages are used to access, manipulate, and graphically display the data.

L. Illari

12.820 Turbulence and Nonlinear Waves in the Ocean and Atmosphere
Prereq: 12.803
G (Spring)
3-0-6 H-LEVEL Grad Credit

Introduction to turbulence in geophysical systems, including 3-D, 2-D, and quasi-geostrophic turbulence. Transition to turbulence through primary and secondary instabilities. Statistical theories of fully-developed turbulence. Influence of stratification and rotation. Parameterization of turbulent processes in ocean models.

R. Ferrari, G. Flierl

12.823 Modeling the Biology and Physics of the Ocean
Prereq: 18.075 or 18.085
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-6 H-LEVEL Grad Credit


199
layer, upwelling regimes, mesoscale eddies, and oceanic gyres.

G. Flierl

12.824 Stability Theory for Oceanic & Atmospheric Flows
Prereq: 12.802 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Basic theory of hydrodynamic instability with special application to flows of interest in oceanography and meteorology. Topics covered include general formulation of stability theory; concept of normal modes and linearization; fundamental stability theorems; baroclinic instability: Charney model, Eady model and the Phillips two-layer model; energy transformations; initial value theory and non-modal instability; barotropic instability for jets and shear layers; radiating instabilities; initial value problems applied to the concepts of convective, absolute and spatial instabilities; finite amplitude theory; stability of non-parallel flows.

G. Flierl

12.830 Topics in Waves and Instability
Prereq: 12.803; 12.802 or 12.810
G (Fall)
3-0-9 H-LEVEL Grad Credit

A detailed presentation of selected advanced topics in waves and instability in the atmosphere. The precise selection varies from year to year. Topics have included wave-mean flow interaction, the quasi-biennial oscillation, sudden warmings, critical-level behavior, wave refraction, nonlinear equilibration, wave breaking, tropical waves, and stationary waves.

R. S. Lindzen

12.831 Dynamics and Transport in the Stratosphere
Prereq: 12.803 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit


R. A. Plumb

12.834 Prediction and Predictability of the Atmospheres and Oceans
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Forecasting is the ultimate form of model validation, but even if a perfect model is in hand, imperfect forecasts are likely. Taking a dynamical systems approach, this subject covers the factors that limit our ability to produce good forecasts, shows how the quality of forecasts can be gauged a priori (predicting our ability to predict!), and covers the state of the art in operational atmosphere and ocean forecasting systems.

J. Hansen

12.835 Experimental Atmospheric Chemistry
(Subject meets with 12.335)
Prereq: Permission of instructor
G (Fall)
2-4-6

See description under subject 12.335.

R. Prinn

12.841 Climate Dynamics
Prereq: 12.801; 12.803 or 12.810
G (Spring)
3-0-9 H-LEVEL Grad Credit

Description of atmospheric and oceanic processes important in determining climate and climate change. Construction and application of simplified models of climate and climate change. Discussion of general circulation model studies of climate and climate change.

EAPS staff

12.842 Climate Physics and Chemistry
(Subject meets with 12.301)
Prereq: Chemistry (GIR), 18.03, or permission of instructor
G (Fall, IAP)
4-0-8 H-LEVEL Grad Credit

See description under subject 12.301.

C. Wunsch, E. Boyle, K. Emanuel

12.848J Global Climate Change: Economics, Science, and Policy
(Same subject as 15.023j, ESD.128j)
(Subject meets with 12.348j, 15.026j)
Prereq: Calculus II (GIR); 5.60; 14.01 or 15.010; or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject 15.023j.

H. D. Jacoby, R. G. Prinn

12.861 Modern Observational Physical Oceanography
Prereq: 12.801 or 12.802; 12.864
G (Fall)
3-0-6 H-LEVEL Grad Credit

Subject provides physical oceanography students with a deeper understanding of how recent oceanic observation programs are changing the long-standing view of how the ocean behaves. Subject covers a variety of topics, with a focus on the ocean as a time-varying system ranging from short (days) to long (millennial) time-scales. New tools and new inferences discussed.

C. Wunsch

12.862 Coastal Physical Oceanography
Prereq: 12.800
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Introduction to the dynamics of flow over the continental shelf, emphasizing both theory and observations. Content varies somewhat according to student and staff interests. Possible topics include fronts, buoyant plumes, surface and bottom boundary layers, wind-driven upwelling, coastal-trapped waves, internal waves, quasi-steady flows, high-latitude shelf processes, tides, and shelf-open ocean interactions.

S. Lentz, C. Cenedese, J. Lerczak (WHOI)

12.863 Special Topics in Coastal Physical Oceanography
Prereq: 12.862 or permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit

More specialized topics in the dynamics of flow over the continental shelf, including coastal-trapped waves, wind-driving, and mean flows. Emphasis on the relationship between theory and observations. Instrumentation and the application of statistical techniques also covered.

Woods Hole Staff

12.864 Inference from Data and Models-Time Series Methods
Prereq: 18.03
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-4 H-LEVEL Grad Credit

Basic methods, taught heuristically, for making sense of discretely sampled data accumulated through time or space. Basic statistical ideas, Fourier methods and power density estimation, z-transforms, sampling theorems, filtering, mul-
titaper methods, coherence, etc. Examples taken across the earth sciences.

C. Wunsch

12.865 Inference from Models and Data—Inverse and State Estimation Methods
Prereq: 18.03
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-4 H-LEVEL Grad Credit

Discrete methods of basic statistics and linear algebra useful for combining realistic, noisy, observations with static and time-evolving models derived from differential and partial differential equations. Singular value decomposition, extended least-squares, sequential methods (Kalman filters, smoothers), Lagrange multiplier (adjoint) methods, etc. Heuristic approach intended for anyone interested in inferences from real data and plausible dynamical and kinematical models.

C. Wunsch

12.866 Theory of the General Circulation of the Ocean
Prereq: 12.800, 12.801, 12.802
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit


R. X. Huang (WHOI)

12.870 Air-Sea Interaction: Boundary Layers
Prereq: Graduate-level fluid mechanics and a subject on waves, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Addresses the interaction of the atmosphere and ocean on temporal scales from seconds to days and spatial scales from centimeters to kilometers. Topics include the generation, propagation, and decay of surface waves; the processes by which mass, heat, momentum, and energy are transported vertically within the coupled atmospheric and oceanic boundary layers and across the air-sea interface; and the statistical tools, mathematical models, and observational methods that are used to quantify these processes.

J. Trowbridge, E. Terray (WHOI)

12.950–12.951 Seminar in Physical Oceanography at MIT
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Topics in physical and dynamical oceanography. Content varying from term to term. 12.950 is letter-graded.

Physical Oceanography Staff

12.960–12.961 Special Problems in Physical Oceanography at MIT
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Special investigations, special laboratory work, or special fieldwork in oceanography. 12.960 is letter-graded.

Physical Oceanography Staff

12.970–12.971 Special Problems in Physical Oceanography at Woods Hole
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Reading, consultation, and original investigation on oceanographic problems. 12.970 is letter-graded.

Woods Hole Staff

12.980–12.981 Special Problems in Meteorology
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Reading, consultation, and original investigations on meteorological problems. 12.980 is letter-graded.

Meteorology Staff

12.990–12.991 Special Subjects in Meteorology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Organized lecture or laboratory subject on some aspect of meteorology not normally covered in regularly scheduled subjects. 12.990 is letter-graded.

Consult Department Headquarters
Bachelor of Science in Earth, Atmospheric, and Planetary Sciences/ Course 12

General Institute Requirements (GIRs) Subjects
Science Requirement 6
Humanities, Arts, and Social Sciences Requirement 8
Restricted Electives in Science and Technology (REST) Requirement [can be satisfied from among 12.001, 12.002, 12.003, and 18.03 or 18.034 in the Departmental Program] 2
Laboratory Requirement 1
Total GIR Subjects Required for SB Degree 17

Communication Requirement
The program includes a Communication Requirement of 4 subjects:
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program Units
Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).
Required Subjects 114–126

Introductory Material
Two of the following core subjects:
12.001 Introduction to Geology, 12, REST (required for concentration Area 1 and Area 4 majors)
12.002 Physics and Chemistry of the Terrestrial Planets, 12, REST; Physics II (GIR), Calculus II (GIR) (required for concentration Area 3 majors)
12.003 Physics of the Atmosphere and Ocean, 12, REST; Physics I (GIR), Calculus II (GIR); (required for concentration Area 2 and Area 4 majors)
12.006J Nonlinear Dynamics I; Chaos, 12; Physics II (GIR), 18.03

One of the following mathematics subjects:
18.03 Differential Equations, 12, REST; Calculus II (GIR)
18.034 Differential Equations, 12, REST; Calculus II (GIR)

The following research subject:
12.TIP Thesis and Independent Study Preparation, 6 and one of the following:
12.IND Independent Study (at least 6 units), CI-M; 12.TIP
12.ThU Undergraduate Thesis (at least 6 units), CI-M; 12.TIP (required for concentration Area 3 and Area 4 majors)

Student must complete one of the following four concentration areas:
AREA 1 Geoscience
12.005 Applications of Continuum Mechanics to Earth, Atmospheric, and Planetary Sciences, 12; Physics II (GIR), Calculus II (GIR), 18.03
12.108 Structure of Earth Materials, 12; Chemistry (GIR)
12.113 Structural Geology, 12; 12.001, 12.005

3.012 Fundamentals of Materials Science and Engineering, 15, REST; 18.03*
or
5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)

One of the following sets of field subjects:
12.221 Field Geophysics, 6
12.214 Environmental Geophysics, 12; 18.03
12.222 Field Geophysics Analysis, 6, CI-M; 12.221
or
12.114 Field Geology I, 6; 12.108, 12.113, or permission of instructor
12.115 Field Geology II, 18, LAB, CI-M; 12.113, 12.114

AREA 2 Atmospheres, Oceans, and Climate
5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)
8.09 Physics II, 12, REST; Physics II (GIR), Calculus II (GIR)
12.330J Fluid Physics, 12; 5.60*
12.333 Atmospheric and Ocean Circulations, 12; 12.003

Two of the following physics and mathematics subjects:
12.008 Classical Mechanics: A Computational Approach, 12; Physics I (GIR), 18.03, permission of instructor or
8.09 Classical Mechanics II, 12; Physics I (GIR)
8.04 Quantum Physics I, 12, REST; 8.03*, 18.03*
8.07 Electromagnetism II, 12; 8.03, 18.03
18.311 Principles of Applied Mathematics, 12; Calculus II (GIR), 18.03*

One of the following laboratory subjects:
12.307 Weather and Climate Laboratory, 12, LAB, CI-M; Calculus II (GIR), Physics I (GIR)
12.335 Experimental Atmospheric Chemistry, 12, LAB, CI-M; Chemistry (GIR)
AREA 3 Planetary Science and Planetary Astronomy
8.03 Physics III, 12, REST; Physics II (GIR), Calculus II (GIR)
8.04 Quantum Physics I, 12, REST; 8.03*, 18.03*
8.046 Statistical Physics I, 12; 8.03, 18.03
12.008 Classical Mechanics: A Computational Approach, 12; Physics I (GIR), 18.03
12.420 Physics and Chemistry of the Solar System, 12; 8.03, 12.002, or permission of instructor

The following laboratory subject:
12.410 Observational Techniques of Optical Astronomy, 15, LAB, CI-M; 8.282*, 8.03

AREA 4 Environmental Science
12.007 Geobiology, 12
12.102 Environmental Earth Science, 12, REST
12.103 Science and Policy of Natural Hazards, 12, CI-M
12.105 Seminar in Environmental Science, 9; 12.120, 12.103; or permission of instructor

Three subjects in one focus area:

Biology focus:
1.018/7.330 Ecology I: The Earth System, 12, REST
7.03 Genetics, 12, REST; Biology (GIR)
5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)

Chemistry focus:
5.03 Principles of Inorganic Chemistry I, 12; 5.12
5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)
5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)

Earth Science focus:
12.110 Sedimentary Geology, 12; 12.001
12.163 Geomorphology, 12, 12.001; Physics I (GIR), Calculus I (GIR)*
12.214 Environmental Geophysics, 12; 12.001

12 units from the following field or laboratory subjects:
5.310 Laboratory Chemistry, 12, LAB; 5.12
12.119 Analytical Techniques for Studying Environmental and Geologic Samples, 12, LAB
12.155 Sedimentary and Surficial Geology Investigations, 12; 12.119*
12.307 Weather and Climate Laboratory, 12, LAB, CI-M; Calculus II (GIR), Physics I (GIR)
12.333 Experimental Atmospheric Chemistry, 12, LAB, CI-M, Chemistry (GIR)

Departmental Program Units That Also Satisfy the GIRs

Restricted Electives
6–27

One or two subjects selected with the approval of the faculty advisor from among EAPS concentration area electives, mathematics, and physics (24 units in Area 1, 6-12 units in Areas 2, and 24-27 units in Area 3).


AREA 3. Choose one: 1.00 or 12.010; Choose one: 18.04, 18.05, 18.06, 18.075

AREA 4. Choose two from a focus:
—Biology: 1.080, 5.07, 5.08, 5.13, 5.43, 9.20, 10.333J, 11.002J, 11.122

Unrestricted Electives
78

Total Units Beyond the GIRs Required for SB Degree
180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes
*Alternate prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
13. ThG Graduate Thesis
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Program of research leading to the writing of an
SM, PhD, or ScD thesis, to be arranged by the
student and an appropriate MIT faculty member.
Consult department headquarters.

M. S. Triantafyllou
14.003 Microeconomic Theory and Public Policy
(Subject meets with 14.03)
Prereq: 14.01
G (Fall, Spring)
4-0-8
Applies microeconomic theory to analysis of public policy. Builds from microeconomic model of consumer behavior; extends to operation of single and multiple markets and analysis of why markets sometimes fail. Empirical examples to evaluate theory, focusing on the casual effects of policy interventions on economic outcomes. Topics include minimum wages and employment, food stamps and consumer welfare, economics of risk and safety regulation, the value of education, and gains from international trade. Graduate students are expected to complete additional assignments.
Fall: D. Autor
Spring: S. Ryan

14.01 Principles of Microeconomics
Prereq: None
U (Fall, Spring)
3-0-9 HASS
Introduces microeconomic concepts and analysis, supply and demand analysis, theories of the firm and individual behavior, competition and monopoly, and welfare economics. Applications to problems of current economic policy.
Fall: W. Wheaton
Spring: J. Harris

14.02 Principles of Macroeconomics
Prereq: None
U (Fall, Spring)
3-0-9 HASS
Provides an overview of macroeconomic issues: the determination of output, employment, unemployment, interest rates, and inflation. Monetary and fiscal policies are discussed. Important current policy debates such as the sub-prime crisis, social security, the public debt, and international economic issues are critically explored. Introduces basic models of macro-economics and illustrates principles with the experience of the US and foreign economies.
Fall: V. Guerrieri
Spring: F. Giavazzi

14.03 Microeconomic Theory and Public Policy
(Subject meets with 14.003)
Prereq: 14.01
U (Fall, Spring)
4-0-8 HASS
Applies microeconomic theory to analysis of public policy. Builds from microeconomic model of consumer behavior; extends to operation of single and multiple markets and analysis of why markets sometimes fail. Empirical examples to evaluate theory, focusing on the casual effects of policy interventions on economic outcomes. Topics include minimum wages and employment, food stamps and consumer welfare, economics of risk and safety regulation, the value of education, and gains from international trade.
Fall: D. Autor
Spring: S. Ryan

14.04 Intermediate Microeconomic Theory
Prereq: 14.01, Calculus II (GIR)
U (Fall)
4-0-8 HASS
Analysis of consumer and producer decisions including analysis of competitive and monopolistic markets. Price-based partial and general equilibrium analysis. Introduction to game theory as a foundation for the strategic analysis of economic situations. Imperfect competition, dynamic games among firms. Failures of general equilibrium theory and their resolutions: externalities, public goods, incomplete information settings, signaling, screening, insurance, alternative market mechanisms, auctions, design of markets.
P. Pathak

14.05 Intermediate Applied Macroeconomics
Prereq: 14.01, 14.02
U (Spring)
4-0-8 HASS
Uses the tools of macroeconomics to study various macroeconomic policy problems in depth. The problems range from economic growth in the long run to government finances in the intermediate run and economic stability in the short run. Many economic models used today are surveyed. Requires a 20-page paper on the economics of long-run economic growth.
G. M. Angeletos

14.06 Advanced Macroeconomics
Prereq: 14.05
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
4-0-8 HASS
Topics in advanced macroeconomics including growth, business cycles, monetary and fiscal policy, consumption and investment under uncertainty, asset pricing, financial intermediation, coordination problems, and crises. Emphasis on models and techniques.
Consult G. M. Angeletos

14.09 Reading Seminar in Economics
Prereq: 14.04, 14.06
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Reading and discussion of particular topics in economics. Open to undergraduate students by arrangement with individual faculty members.
Consult Department Headquarters.
S. Ellison

14.10 Reading Seminar in Economics
Prereq: 14.04, 14.06
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Reading and discussion of particular topics in economics. Open to undergraduate students by arrangement with individual faculty members.
Consult Department Headquarters.
S. Ellison

14.102 Mathematics for Economists
Prereq: Calculus I (GIR), Calculus II (GIR), 18.06
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
4-0-8
Covers some topics in mathematics that are frequently used in economic theory and in applications. Topics include: optimization theory (including optimal control and recursive methods); probability theory; topology (continu-
ity, compactness); dynamical systems (including stability); convex analysis; and fixed point theory. Presentation of each topic self-contained. Consult Department Headquarters.

**14.11 Special Topics in Economics**
Prereq: 14.01
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Considers issues of current research interest in economics. Consult Department Headquarters.

**14.12 Economic Applications of Game Theory**
Prereq: 14.01; 14.03, 6.041 or permission of instructor
U (Fall)
4-0-8 HASS
Analysis of strategic behavior in multi-person economic settings. Introduction to solution concepts, such as rationalizability, backwards induction, Nash equilibrium, subgame-perfect equilibrium, and sequential equilibrium, with a strong emphasis on the assumptions behind these solution concepts. Issues of incomplete information, such as signaling and reputation formation. Applications drawn from microeconomics and political economy. G. Ellison

**14.121 Microeconomic Theory I**
Prereq: 14.04, permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit

**14.122 Microeconomic Theory II**
Prereq: 14.121, permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit
Introduction to game theory. Normal form and extensive form games. Games with incomplete information. Class size limited. G. Ellison

**14.123 Microeconomic Theory III**
Prereq: 14.121, 14.122, permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit
Models of individual decision-making under certainty and uncertainty. Additional topics in game theory. Class size limited. M. Yildiz

**14.124 Microeconomic Theory IV**
Prereq: 14.123, permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit
Decision-making under uncertainty, information economics, incentive and contract theory. Class size limited. S. Baliga

**14.126 Game Theory**
Prereq: 14.122
G (Spring)
3-0-9 H-LEVEL Grad Credit
Rigorous investigation of the evolutionary and epistemic foundations of solution concepts, such as rationalizability and Nash equilibrium. Covers classical topics, such as repeated games, bargaining, and supermodular games as well as new topics such as global games, heterogeneous priors, psychological games, and games without expected utility maximization. Applications provided when available. M. Manea, M. Yildiz

**14.129 Advanced Contract Theory**
Prereq: 14.121, 14.281, or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
Recent developments in contract theory. Includes advanced models of moral hazard, adverse selection, mechanism design and incomplete contracts with applications to theory of the firm, organizational design, and financial structure. R. Townsend

**14.13 Economics and Psychology**
Prereq: 14.03
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
4-0-8 HASS
Introduction to theoretical and empirical literature in the new field of behavioral economics. Examines important and systematic departures from the predictions of the standard model in economics; covers intertemporal tradeoffs, risk preferences, social preferences, and intrinsic motivation; and applies theory to many different areas, such as credit card debt, addiction, portfolio choices, labor supply, and compensation policies of firms. Students review evidence from lab experiments, examine how the results can be integrated into models, and test models using field and lab data. Consult Department Headquarters.

**14.137 Psychology and Economics**
Prereq: None
G (Spring)
4-0-8
Examines “psychology appreciation” for economics students. Aims to enhance knowledge and intuition about psychological processes in areas relevant to economics. Increases understanding of psychology as an experimental discipline, with its own distinct rules and style of argument. Topics include self-knowledge, cognitive dissonance, self-deception, emotions, social norms, self-control, learning, mental accounting, memory, individual and group behavior, and some personality and psycho-analytic models. Within each of these topics, we showcase effective and central experiments and discuss their role in the development of psychological theory. Term paper required. D. Prelec

**14.147 Topics in Game Theory**
Prereq: 14.126
G (Fall)
4-0-8 H-LEVEL Grad Credit
Advanced subject on topics of current research interest. P. Pathak

**14.15J Networks (New)**
(Same subject as 6.207J)
Prereq: 6.041 or 14.30
U (Fall)
4-0-8 HASS
Highlights common principles that permeate the functioning of diverse technological, economic and social networks. Utilizes three sets of tools for analyzing networks—random graph models, optimization, and game theory—to study informational and learning cascades; economic and financial networks; social influence networks; formation of social groups; communication networks and the Internet; consensus and gossiping; spread and control of epidemics; control and use of energy networks; and biological networks. D. Acemoglu, A. Ozdaglar
14.195, 14.196 Reading Seminar in Economics
Prereq: 14.121
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Reading and discussion of special topics in economics. Open to advanced graduate students by arrangement with individual members of the staff.
Consult Department Headquarters

14.197, 14.198 Teaching Introductory Economics
Prereq: None
G (Fall, Spring)
2-0-2 [P/D/F]
Can be repeated for credit
Required of teaching assistants in introductory economics (14.01 and 14.02), under supervision of the faculty member in charge of the subject.
14.198: W. Wheaton, J. Harris
14.199: V. Guerrieri, F. Giavazzi

INDUSTRIAL ORGANIZATION

14.20 Industrial Organization and Competitive Strategy
Prereq: 14.01
U (Spring)
4-0-8 HASS
Analyzes the behavior and performance of firms in markets, with a particular focus on strategic interactions. Topics include monopoly power, behavior of firms in oligopoly markets, static and dynamic measurement of market performance, pricing and product choice decisions, advertising, research and development, and theory of the firm. Requires team participation in a Competitive Strategy Game.
N. Rose

14.21J Health Economics
(Same subject as HST.901J)
Prereq: 14.01
U (Fall)
3-0-9 HASS
Applies theoretical and empirical tools of economics to problems of health and medical care delivery. Concentrates on selected problems such as the welfare economics of "health" as a commodity, hospitals and the nonprofit sector, human capital and medical manpower, and innovation in medicine.
J. E. Harris

14.26 Economics of Incentives: Theory and Applications
Prereq: 14.04
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
4-0-8 HASS
Rigorous introduction to the economic theory of incentives, including moral hazard, adverse selection, and dynamic incentive problems. Applications include the design of optimal sales and CEO compensation schemes; the analysis of venture capital and other forms of financing; and the study of joint stock companies, co-operatives, and other types of organizations viewed as optimal adaptations to information and incentive problems.
Consult B. Holmstrom

14.271 Industrial Organization I
Prereq: 14.04
G (Fall)
4-0-8 H-LEVEL Grad Credit
Covers theoretical and empirical work dealing with the structure, behavior, and performance of firms and markets and core issues in antitrust. Topics include: the organization of the firm, monopoly, price discrimination, oligopoly, and auctions. Theoretical and empirical work are integrated in each area.
G. Ellison

14.272 Industrial Organization II
Prereq: 14.271
G (Spring)
4-0-8 H-LEVEL Grad Credit
A continuation of 14.271. Topics covered include horizontal mergers and demand estimation, vertical integration and vertical restraints, natural monopoly and its regulation, public enterprise, political economy of regulation, network access pricing, deregulation of telecommunications, electric power, cable television, transportation sectors, and risk and environmental regulation.
N. Rose, S. Ryan

14.273 Advanced Topics in Industrial Organization
Prereq: 14.271
G (Spring)
4-0-8 H-LEVEL Grad Credit
Introduction to current research in industrial organization, focusing on a specific set of issues that varies from year to year.
P. Jia, S. Ryan
14.281 Contract Economics
Prereq: 14.124
G (Fall)
4-0-8 H-LEVEL Grad Credit
Covers theoretical and empirical research on contracts. The presentation is organized around different types of models (agency, property rights, transaction costs, relational contracts), but with serious attention paid to applications and empirical studies of these models. Potential applications include executive compensation, insurance, transfer pricing, internal labor and capital markets, vertical and horizontal integration, alliances and joint ventures, entrepreneurship and liquidity demand.
B. Holmstrom

14.282 Introduction to Organizational Economics
Prereq: 14.124
G (Fall)
4-0-8 H-LEVEL Grad Credit
Beginns with survey of contract theory for organizational economists, then introduces the main areas of the field, including the boundary of the firm; decision-making, employment, structures and processes in organizations; contracts between firms; and organizations other than firms. R. Gibbons

14.283 Advanced Topics in Organizational Economics I (New)
Prereq: 14.282
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
14.284 Advanced Topics in Organizational Economics II (New)
Prereq: 14.282
G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit
Builds on the work done in 14.282 to develop more in-depth analysis of topics in the field. 12.283: R. Gibbons 12.284: L. Garicano

14.286j Health Economics Seminar
(Same subject as HST.903J)
Prereq: 14.04, permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Advanced subject in economics of health care sector. Considers selected topics in depth, such as design and financing of health insurance, behavior of nonprofit hospitals, role of competition in the medical care market, determinants of technological change, and effects of government regulations.
J. E. Harris

14.295j Collective Choice II
(Same subject as 17.814J)
Prereq: 17.812) or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 17.814J.
J. M. Snyder, Jr.

14.296j Collective Choice I
(Same subject as 17.812J)
Prereq: None
G (Fall)
4-0-8
See description under subject 17.812J.
J. M. Snyder, Jr.

Statistics and Econometrics

14.30 Introduction to Statistical Method in Economics
Prereq: Calculus II (GIR)
U (Fall, Spring)
4-0-8 REST
Self-contained introduction to probability and statistics with some economic applications. Elements of probability theory, sampling theory, statistical estimation, and hypothesis testing. May not count toward HASS requirement.
Consult Department Headquarters

14.32 Econometrics
Prereq: 14.30
U (Fall, Spring)
4-0-8
Introduction to econometric models and techniques, simultaneous equations, program evaluation, emphasizing regression. Advanced topics include instrumental variables, panel data methods, measurement error, and limited dependent variable models. Includes problem sets. May not count toward HASS requirement.
Fall: S. Ellison
Spring: W. Newey

14.33 Research and Communication in Economics: Topics, Methods, and Implementation
Prereq: 14.04, 14.05, 14.32
U (Fall, Spring)
3-4-5 Institute LAB
Exposes students to the process of conducting independent research in empirical economics and effectively communicating the results of the research. Emphasizes econometric analysis of an assigned economic question and culminates in each student choosing an original topic, performing appropriate analysis, and delivering oral and written project reports.
Fall: S. Ellison
Spring: A. Finkelstein

14.36 Advanced Econometrics
Prereq: 14.30, 14.32
U (Spring)
4-0-8
Covers a range of topics including duration models, discrete choice models, differentiated product models, count models and other advanced models that are used in a wide variety of applications in applied microeconomics, financial economics, and business economics. Mastery of one or more techniques taught in class demonstrated through the completion of an econometrics paper.
J. Hausman

14.381 Statistical Method in Economics
Prereq: Calculus II (GIR), permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Introduction to probability and statistics as background for advanced econometrics and introduction to the linear regression model. Elements of probability theory; sampling theory; asymptotic approximations; decision-theory approach to statistical estimation focusing on regression, hypothesis testing; and maximum-likelihood methods. Simple and multiple regression, estimation and hypothesis testing. Illustrations from economics and application of these concepts to economic problems. Class size limited.
V. Chernozhukov, A. Mikusheva

14.382 Econometrics
Prereq: 14.381 or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
Regression analysis, focusing on departures from the standard Gauss-Markov assumptions, and simultaneous equations. Regression topics include heteroskedasticity, serial correla-
tion, and errors in variables, generalized least squares, nonlinear regression, and limited dependent variable models. Covers identification and estimation of linear and nonlinear simultaneous equations models. Economic applications are discussed. Class size limited.

J. Hausman

14.384 Time Series Analysis
Prereq: 14.382 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

Theory and application of time series methods in econometrics, including spectral analysis, estimation with stationary and non-stationary processes, VARs, factor models, unit roots, cointegration, estimation of DSGE models, Bayesian methods. Class size limited.

A. Mikusheva

14.385 Nonlinear Econometric Analysis
Prereq: 14.382 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

Microeconometric models, including large sample theory for estimation and hypothesis testing, generalized method of moments, estimation of censored and truncated specifications, quantile regression, structural estimation, nonparametric and semiparametric estimation, panel data, bootstrapping, and simulation methods. Methods illustrated with economic applications. Class size limited.

V. Chernozhukov, W. Newey

14.386 New Econometric Methods
Prereq: 14.382
G (Spring)
4-0-8 H-LEVEL Grad Credit

Focuses on recent developments in econometrics, especially structural estimation. Topics include nonseparable models, models of imperfect competition, auction models, duration models, and nonlinear panel data. Results illustrated with economic applications.

W. Newey

14.387 Topics in Applied Econometrics
Prereq: 14.382
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit

Covers core econometric ideas and empirical modeling strategies widely used in contemporary applied microeconomic research. Topics vary from year to year but typically include the interpretation and use of regression models, matching and the propensity score, instrumental variables methods, and statistical inference problems such as clustering. May also cover areas of special interest to class participants.

J. Angrist

14.389 Econometrics Paper
Prereq: 14.382 or 14.32
G (IAP)
0-0-3 H-LEVEL Grad Credit

Paper in econometrics required of all PhD candidates, due at the end of IAP.

J. Hausman

14.391 Workshop in Economic Research
Prereq: 14.124, 14.454
G (Fall)
2-0-10 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

14.392 Workshop in Economic Research
Prereq: 14.124, 14.454
G (Spring)
2-0-10 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Develops research ability of students through intensive discussion of dissertation research as it proceeds, individual or group research projects, and critical appraisal of current reported research. Workshops divided into various fields, depending on interest and size.

Consult E. Duflo

Civil and Environmental Engineering: 1.151, 1.155, 1.202J, 1.203J, 1.205J

Electrical Engineering and Computer Science: 6.041, 6.231, 6.245, 6.262, 6.431, and 6.435

Management: 15.034, 15.070, 15.075, and 15.098

Mathematics: 18.05, 18.175, 18.177, 18.440, 18.443, 18.445, and 18.465

See also: 2.830, 5.70, 5.72, 7.02, 8.044, 8.08, 10.816, 11.220, 11.221, 16.322, 22.38, HST.191, and MAS.622J

NATIONAL INCOME AND FINANCE

14.41 Public Finance and Public Policy
Prereq: 14.01
U (Fall)
4-0-8 HASS

Explores the role of government in the economy, applying tools of basic microeconomics to answer important policy questions such as
government response to global warming, school choice by K-12 students, Social Security versus private retirement savings accounts, government versus private health insurance, setting income tax rates for individuals and corporations.

J. Gruber

14.416J Introduction to Financial Economics
(Same subject as 15.416J)
Prereq: 14.121, 14.122
G (Fall)
4-0-8 H-LEVEL Grad Credit

See description under subject 15.416J.

S. A. Ross

14.42 Environmental Policy and Economics
(Subject meets with 14.420)
Prereq: 14.01
U (Spring)
4-0-8 HASS

14.420 Environmental Policy and Economics
(Subject meets with 14.42)
Prereq: 14.01
G (Spring)
4-0-8 H-LEVEL Grad Credit

Investigates the proper role of government in the regulation of the environment. Explores the tools necessary to estimate the costs and benefits of environmental regulations and to evaluate a series of current policy questions regarding air and water pollution, the costs of climate change in the US and abroad, and whether there is a “race to the bottom” in environmental regulation. Students help design and execute a research project that tests whether air pollution causes infant mortality. Students taking the graduate version complete additional assignments. Completion of 14.30 recommended.

M. Greenstone

(New)
(Same subject as 15.031J, 21A.341J)
Prereq: 14.01 or permission of instructor
U (Spring)
4-0-8

See description under subject 15.031J.

D. Lessard, R. Schmalensee, S. Silbey

14.44 Energy Economics and Policy
(Subject meets with 14.444)
Prereq: 14.01
U (Spring)
4-0-8 HASS

See description under subject 14.444.

G. Metcalf
(Same subject as 15.440J)
Prereq: 15.416J
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 15.440J.
L. Kogan

14.441J Advanced Financial Economics II
(Same subject as 15.441J)
Prereq: 14.121, 14.122, or 15.416J
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 15.441J.
S. Myers, A. Schoar

(Same subject as 15.442J)
Prereq: 14.382, 15.416J, or permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 15.442J.
J. Pan

14.444 Energy Economics and Policy
(Subject meets with 14.44)
Prereq: 14.01
G (Spring)
4-0-8
Theoretical and empirical perspectives on individual and industrial demand for energy, energy supply, energy markets, and public policies affecting energy markets. Discusses aspects of the oil, natural gas, electricity, and nuclear power sectors. Examines energy tax, price regulation, deregulation, energy efficiency and policies for controlling pollution and CO₂ emissions. Additional work is required of graduate students. Enrollment in each subject is limited to 30 students.
G. Metcalf

14.45 Financial Economics
Prereq: 14.03 or 14.04; 14.32
U (Fall)
4-0-8 HASS
Self-contained introduction to the theory of investment decisions under uncertainty. Topics include interest rates, net present value, fixed income securities, the term structure of interest rates, portfolio separation theorems, capital asset pricing models, factor models, risk neutral pricing, valuation of options, and intertemporal consumption and investment models. Emphasis on empirical implementation of theoretical concepts.
V. Chernozhukov

14.451 Dynamic Optimization Methods with Applications
Prereq: 14.06, permission of instructor
G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
Provides an introduction to dynamic optimization methods, including discrete-time dynamic programming in non-stochastic and stochastic environments, and continuous time methods including the Pontryagin maximum principle. Applications may include the Ramsey model, irreversible investment models, and consumption choices under uncertainty. Class size limited.
G. Lorenzoni

14.452 Economic Growth
Prereq: 14.451, permission of instructor
G (Fall; second half of term)
2-0-4 H-LEVEL Grad Credit
Introduction to the sources and modeling of economic growth and income differences across nations. Topics include introduction to dynamic general equilibrium theory, the neoclassical growth model, overlapping generations, determinants of technological progress, endogenous growth models, measurement of technological progress, the role of human capital in economic growth, and growth in a global economy. Class size limited.
D. Acemoglu

14.453 Economic Fluctuations
Prereq: 14.452, permission of instructor
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
Investigation of why aggregate economic activity fluctuates, and the role of policy in affecting fluctuations. Topics include the link between monetary policy and output, the economic cost of aggregate fluctuations, the costs and benefits of price stability, and the role of central banks. Introduction to real business cycle and new Keynesian models. Class size limited.
G. M. Angeletos

14.454 Economic Crises
Prereq: 14.453, permission of Instructor
G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit
Introduction to current macroeconomic concerns with particular emphasis on medium-run economic fluctuations, economic crises, and the role of asset markets. Topics include the explanation of high chronic unemployment in some nations, the source of modern liquidity crises, the origin and end of speculative bubbles, and the factors that lead to substantial periods of economic stagnation. Class size limited.
R. Caballero

14.456 Topics in Macroeconomics
Prereq: 14.454
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall; second half of term)
Units arranged H-LEVEL Grad Credit
Advanced subject on topics of current research interest in macroeconomics.
Consult Department Headquarters

14.461 Advanced Macroeconomics I
Prereq: 14.122, 14.452
G (Fall)
4-0-8 H-LEVEL Grad Credit
First part focuses on monetary economics. Second part focuses on information and coordination problems: recent advances in global games; the impact of expectations about one another’s actions; welfare effects and policy implications; applications to financial crises (currency attacks, bank runs, etc.), monetary policy, and business cycles. Other topics may include recent work on incomplete markets, capital accumulation, and wealth inequality.
V. Guerrieri, G. Lorenzoni

14.462 Advanced Macroeconomics II
Prereq: 14.461
G (Spring)
4-0-8 H-LEVEL Grad Credit
Advanced topics on business cycles and crises; informational frictions; coordination problems; global games; DSGE models; financial frictions.
G. M. Angeletos

14.463 Advanced Macroeconomics III
Prereq: 14.451
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
4-0-8 H-LEVEL Grad Credit
Advanced topics of current interest in macroeconomics. Exact set of topics adjusted according to the interests of the group.
Consult Department Headquarters

14.47I Public Economics I
Prereq: 14.04
G (Fall)
4-0-8 H-LEVEL Grad Credit
Theory and evidence on government taxation policy. Topics include tax incidence; optimal tax
theory; the effect of taxation on labor supply and savings; taxation and corporate behavior; and tax expenditure policy.
J. Poterba, E. Saez

14.472 Public Economics II
Prereq: 14.471
G (Spring)
3-0-9 H-LEVEL Grad Credit

Theory and evidence on government expenditure policy. Topics include the theory of public goods; social insurance programs such as social security and unemployment insurance; health care policy; redistribution and the welfare state.
P. Diamond, A. Finkelstein

14.474 Advanced Topics in Public Economics
Prereq: 14.124
G (Fall)
4-0-8 H-LEVEL Grad Credit

Introduction to current research in public economics, with a focus on the impact of taxation and government policy on household and firm behavior.
E. Saez

14.475 Environmental Economics and Government Responses to Market Failure
Prereq: None
G (Spring)
4-0-8

Theory and evidence on regulatory, tax, and other government responses to problems of market failure. Special emphasis on developing and implementing tools to evaluate environmental policies. Topics include cost-benefit analysis, measurement of the benefits of non-market goods and costs of regulations, and the evaluation of the impact of regulations in areas such as financial markets, workplace health and safety, consumer product safety, and other contexts.
M. Greenstone

14.48) Economics of Education
(Subject meets with 11.126)
(Subject meets with 11.249)
Prereq: 14.01
U (Spring)
4-0-8 HASS

See description under subject 11.126.
F. Levy

14.49 Information Technology and the US Labor Market
(Subject meets with 11.128, 11.248)
Prereq: 14.01
U (Spring)
4-0-8 HASS

Combines economic theory, econometric studies, workplace case studies, and other relevant literature to examine the impact of computerization and, more generally, information technology, on US employment and wages. Topics include: recent trends in wages and employment; estimates of the impact technological innovations have on labor demand; the relationship between rules-based logic and “high” and “low” skilled occupations; and the uses and limits of information technology in assisting students and workers to learn new skills.
F. Levy

INTERNATIONAL, INTERREGIONAL, AND URBAN ECONOMICS

14.54 International Trade
Prereq: 14.01, 14.02
U (Spring)
4-0-8 HASS

Introduction to the theory of international trade and finance with applications to current policy issues.
A. Costinot

14.573* Cities and Regions: Urban Economics and Public Policy
(Same subject as 1.283J, 11.410J, ESD.191J)
Prereq: 14.03 or 14.04
G (Spring)
3-0-9 H-LEVEL Grad Credit

The theory of urban land and housing markets, and the spatial development of cities. The roles played by transportation systems and local governments in shaping urban location patterns. Interregional competition, economic development, and the migration of labor and capital.
W. Wheaton

14.581 International Economics I
Prereq: 14.04
G (Spring)
4-0-8 H-LEVEL Grad Credit

Theory of international trade and foreign investment with applications in commercial policy.
A. Costinot, D. Donaldson

14.582 International Economics II
Prereq: 14.06
G (Fall)
4-0-8 H-LEVEL Grad Credit

International capital flows, exchange rate fluctuations, global capital markets, emerging markets, crises, sovereign debt, international financial architecture, and bubbles.
G. Lorenzoni, R. Rigobon

LABOR ECONOMICS AND INDUSTRIAL RELATIONS

14.63 The American Labor Force in a Changing Economy
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 4

Examines the role of technology, class, gender, race, and age through a historical discussion of important changes in the US economy over the last two centuries: the entrance of women into the paid labor force, the exit of older men out of paid labor, immigration, and the end of segregation.
M. Piore

14.64 Labor Economics and Public Policy
Prereq: 14.30
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
4-0-8 HASS

Provides an introduction to the labor market, how it functions, and the important role it plays in people’s lives world-wide. Topics include minimum wages, labor market effects of social insurance and welfare programs, the collective bargaining relationship, discrimination, human capital, and unemployment. Completion of 14.03 recommended.
J. Angrist

14.661 Labor Economics I
Prereq: 14.04, 14.32
G (Fall)
4-0-8 H-LEVEL Grad Credit

A systematic development of the theory of labor supply, labor demand, and human capital. Topics include wage and employment determination, turnover, search, immigration, unemployment, equalizing differences, and institutions in the labor market. Particular emphasis on the interaction between theoretical and empirical modeling.
D. Acemoglu, J. Angrist
14.662 Labor Economics II
Prereq: 14.64 or 15.660
G (Spring)
4-0-8 H-LEVEL Grad Credit
The development and evolution of labor market structures and institutions. Particular focus on competing explanations of recent developments in the distribution of wage and salary income and in key institutions and organizational structures. Special attention to theories of worker motivation and behavior, the determination of wages, technology, and social stratification.
D. Autor, M. Piore

14.663 Advanced Topics in Labor Economics
Prereq: 14.661
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
4-0-8 H-LEVEL Grad Credit
Introduction to current research in labor economics, focusing on a specific set of issues that varies from year to year.
Consult D. Autor

14.665J Labor Market Regulation and Career Mobility
(Same subject as 17.314J)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 17.314J.
Consult M. Piore

14.670J Medieval Economic History in Comparative Perspective
(Same subject as 21H.416J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS-D, Category 5
See description under subject 21H.416J.
A. McCants

14.71 Economic History of Financial Crises
Prereq: 14.01, 14.02
U (Fall)
4-0-8 HASS
Historical perspective on financial panics. Topics include the growth of the industrial world, the Great Depression and surrounding events, and more recent topics such as the first oil crisis, Japanese stagnation, and conditions following the financial crisis of 2008.
P. Temin

14.72 Capitalism and Its Critics
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 4
Addresses the evolution of the modern capitalist economy and evaluates its current structure and performance. Various paradigms of economics are contrasted and compared (neoclassical, Marxist, socioeconomic, and neocorporate) in order to understand how modern capitalism has been shaped and how it functions in today’s economy. Readings include classics in economic thought as well as contemporary analyses.
Stresses general analytic reasoning and problem formulation rather than specific analytic techniques. May not be used for economics concentration. One economics HASS-D subject may be used as an economics elective for the economics major and minor.
M. Piore

14.73 The Challenge of World Poverty
Prereq: None
U (Fall)
4-0-8 HASS
Designed for students who are interested in the challenge posed by massive and persistent world poverty. Examines extreme poverty over time to see if it is no longer a threat, why some countries grow fast and others fall further behind, if growth or foreign aid help the poor, what we can do about corruption, if markets or NGOs should be left to deal with poverty, where to intervene, and how to deal with the disease burden and improve schools.
E. Duflo, D. Donaldson

14.74 Foundations of Development Policy
Prereq: 14.01, 14.30
U (Fall)
4-0-8 HASS
Explores the foundations of policy making in developing countries. Goal is to spell out various policy options and to quantify the tradeoffs between them. Special emphasis on education, health, gender, fertility, adoption of technological innovation, and the markets for land, credit, and labor.
E. Duflo, D. Donaldson

14.75 Political Economy and Economic Development
Prereq: 14.01, 14.30
U (Spring)
4-0-8 HASS
Explores the relationship between political institutions and economic development, covering key theoretical issues as well as recent empirical evidence. Topics include corruption, democracy, ethnic conflict, and war.
B. Olken

Prereq: 14.121, 14.122
G (Fall)
4-0-8 H-LEVEL Grad Credit
E. Duflo, B. Olken

14.772 Development Economics: Macroeconomics
Prereq: 14.121, 14.451
G (Spring)
4-0-8 H-LEVEL Grad Credit
Dynamic models of growth and development emphasizing migration, modernization, and technological change; static and dynamic models of political economy; the dynamics of income distribution and institutional change; firm structure in developing countries; development, transparency, and functioning of financial markets; privatization; and banks and credit market institutions in emerging markets.
B. Olken, R. Townsend
14.773 Political Economy: Institutions and Development
Prereq: 14.121, 14.451
G (Spring)
4-0-8 H-LEVEL Grad Credit

Economists and policymakers increasingly realize the importance of political institutions in shaping economic performance, especially in the context of understanding economic development. Work on the determinants of economic policies and institutions is in its infancy, but is growing rapidly. Subject provides an introduction to this area. Topics covered: the economic role of institutions; the effects of social conflict and class conflict on economic development; political economic determinants of macro policies; political development; theories of income distribution and distributional conflict; the efficiency effects of distributional conflict; the causes and consequences of corruption; the role of colonial history; and others. Both theoretical and empirical approaches discussed. Subject can be taken either as part of the Development Economics or the Positive Political Economy fields.

D. Acemoglu, B. Olken

14.778J Economic Institutions and Growth Policy Analysis
(Same subject as 11.486J, 17.184J)
Prereq: 11.203
G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject 11.486J.

A. Amsden, M. Piore

14.781J Political Economy I: Theories of the State and the Economy
(Same subject as 15.678J, 17.100J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 17.100J.

M. Piore, S. Berger

14.ThU Thesis
Prereq: 14.33
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

Program of research and writing of thesis.

Staff

14.UR Undergraduate Research
Prereq: 14.02
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

14.URG Undergraduate Research
Prereq: 14.02
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Program of research and writing of thesis.

Consult A. Mikusheva

14.UG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Program of research and writing of thesis; to be arranged by the student with supervising committee.

Staff
**Bachelor of Science in Economics/Course 14**

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td>17</td>
</tr>
</tbody>
</table>

**Communication Requirement**
The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- 2 subjects designated as Communication Intensive in the Major (CI-M).

### PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites if any (corequisites in italics).

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>14.01 Principles of Microeconomics, 12, HASS</td>
<td>96–99</td>
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<tr>
<td>14.02 Principles of Macroeconomics, 12, HASS</td>
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<tr>
<td>14.04 Intermediate Microeconomic Theory, 12, HASS; 14.01, Calculus II (GIR)</td>
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<tr>
<td>14.05 Intermediate Applied Macroeconomics, 12, HASS, CI-M; 14.01, 14.02</td>
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<tr>
<td>14.30 Introduction to Statistical Method in Economics, 12, REST; Calculus II (GIR)</td>
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<tr>
<td>14.32 Econometrics, 12, 14.30</td>
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<tr>
<td>14.33 Research and Communication in Economics, 12, LAB, CI-M; 14.04, 14.05, 14.32</td>
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<tr>
<td>14.34 Thesis (15 units), 14.33</td>
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</tbody>
</table>

| Restricted Electives | Elective subjects in economics | 60 |

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<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th>Units</th>
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<tr>
<td>(60)</td>
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<tr>
<th>Unrestricted Electives</th>
<th>Units</th>
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<td>(81–84)</td>
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</table>

**Total Units Beyond the GIRs Required for SB Degree**

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student's departmental program will count toward one or the other, but not both.

**Notes**
- Alternate prerequisites and corequisites are listed in the subject description.
- No more than three subjects in economics may be used for the Humanities, Arts, and Social Sciences Requirement.
- Or an approved alternative in statistics.
- May be replaced by an additional elective subject in economics.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
MANAGERIAL ECONOMICS

15.002 Sloan Innovation Period Requirement
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Units assigned to MBA students upon completion of the Sloan Innovation Period requirement. MBAs only.
T. Walor

15.010 Economic Analysis for Business Decisions
Prereq: 14.01
G (Fall)
4-0-5 H-LEVEL Grad Credit
15.011 Economic Analysis for Business Decisions
Prereq: 14.01
G (Fall)
4-0-5
Introduces students to principles of microeconomic analysis used in managerial decision-making. Topics include demand, cost and surplus analysis, the behavior of competitive and non-competitive markets, sources and uses of market power, and game theory and competitive strategy, with applications to various business and public policy decisions. Antitrust policy and other government regulations are also discussed. 15.010 restricted to first-year Sloan master’s students. 15.011 primarily for non-Sloan School students.
J. Doyle

15.012 Applied Micro- and International Economics
Prereq: None
G (Spring; first half of term)
2-0-4
Uses case studies to investigate the macroeconomic environment in which firms operate. First half of course develops the basic tools of macroeconomic management: monetary, fiscal, and exchange rate policy. Discusses recent emerging market and financial crises, examining their causes, how best to address them, and how to prevent them from recurring in the future. Second half evaluates different strategies of economic development. Topics include growth, the role of debt and foreign aid, and the reliance on natural resources.
R. Rigobon, T. Suri, L. Throuw

15.013 Industrial Economics for Strategic Decisions
Prereq: 15.010 or 15.011
G (Fall)
3-0-9 H-LEVEL Grad Credit
Applies principles of industrial economics most relevant for corporate strategy to analysis of particular industries. Topics include market structure and its determinants; rational strategic behavior in small numbers situations; strategies for price and nonprice competition; dynamic pricing, output, and advertising decisions; entry and entry deterrence; network externalities, investments in real options, evolution of industries.
R. Pindyck, R. Schmalensee

15.014 Macroeconomic Development and Sustainability
Prereq: 15.012 or 15.015
G (Fall; second half of term)
2-0-4 H-LEVEL Grad Credit
Builds on 15.012 to establish an understanding of the development processes of societies and economies, the role of social entrepreneurship, and consequences for sustainability. Discusses current challenges that face emerging markets: health and the HIV epidemic, education and poverty, the emergence of financial and other markets, inflation and the role of commodity prices, macroeconomic management and the implications for policy. Across all dimensions, considers the roles of private and social entrepreneurs, as well as the public sector.
R. Rigobon, T. Suri

15.015 Macro and International Economics
Prereq: Permission of instructor
G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
Focuses on the policy and economic environment of firms. Subject divided in three parts: study of the closed economy and how monetary and fiscal policy interacts with employment, GNP, inflation, and interest rates; examination of national economic strategies for development and growth, and study of the recent financial and currency crises in emerging markets; study of the problems faced by transition economies and the role of institutions both as the engine of growth, and as the constraints for policy. Restricted to Sloan Fellows in Innovation and Global Leadership.
R. Rigobon

15.018 Global Economic Challenges
Prereq: Permission of instructor
G (Spring; first half of term)
3-0-3 H-LEVEL Grad Credit
Builds on the basic tools of macro and international economics to provide in-depth analysis of major global economic challenges. First half of course examines causes of, and responses to, financial crises. Begins with historical examples and builds up to the current global crisis. Covers topics such as bubbles, financial contagion, capital controls, and crisis prediction. Second half explores major global economic challenges, such as aging populations, global warming, massive trade imbalances, sovereign wealth funds, inequality and poverty, oil and commodity markets, outsourcing, foreign aid, international institutions, and the implications of increased competition from the BRICS (Brazil, Russia, India, and China) and “frontier” economies. Completion of 15.012 or 15.015 recommended.
K. Forbes

15.021J Real Estate Economics
(Same subject as 11.433J)
Prereq: 14.01, 15.010, or 15.011
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 11.433J.
W. C. Wheaton

15.023J Global Climate Change: Economics, Science, and Policy
(Same subject as 12.848J, ESD.128J)
(Subject meets with 12.348J, 15.026J)
Prereq: Calculus II (GIR); 5.60; 14.01 or 15.010; or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Introduces scientific, economic, and ecological issues underlying the threat of global climate change, and the institutions engaged in negoti-
15.024 Applied Economics for Managers
Prereq: Permission of instructor
G (Summer)
3-0-6 H-LEVEL Grad Credit
Develops facility with concepts, language, and analytical tools of economics. Primary focus on microeconomics, analysis of markets and strategic interactions among firms. Emphasizes integration of theory, data, and judgment in the analysis of corporate decisions, and in the assessment of the changing global business environment. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.
T. Stoker

15.025 Game Theory for Strategic Advantage
Prereq: 15.010
G (Spring)
3-0-6 H-LEVEL Grad Credit
Develops and applies principles of game theory relevant to managers' strategic decisions. Topics include how to reason about strategies; “irrational” actions, reputation, and beliefs; entry deterrence; strategic substitutes and complements; brinkmanship and negotiation; and auctions. Applications to a variety of business decisions that arise in different industries.
Staff

15.026J Global Climate Change: Economics, Science, and Policy (New)
(Same subject as 12.348J)
Subject meets with 12.848J, 15.023J, ESD.128J
Prereq: Calculus II (GIR); 5.60; 14.01 or 15.010; or permission of instructor
U (Spring)
3-0-6
See description under subject 15.023J. 12.340 recommended for undergraduates.
H. D. Jacoby, R. G. Prinn

15.031J Energy Decisions, Markets, and Policies (New)
(Same subject as 14.43J, 21A.341J)
Prereq: 14.01 or permission of instructor
U (Spring)
4-0-8
Structured around choices and constraints regarding sources and uses of energy by households, firms, and governments. Introduces managerial, economic, political, social and cultural frameworks for describing and explaining behavior at various levels of aggregation; includes examples of cost-benefit, organizational and institutional analyses of energy generation, distribution, and consumption. Topics include the role of markets and prices; financial analysis of energy-related investments; institutional path dependence; economic and political determinants of government regulation and the impact of regulation on decisions; other forms of government action and social norms regarding desired behavior and opportunities for businesses and consumers, including feedback into the political/regulatory system. Examples drawn from a wide range of countries and settings.
D. Lessard, R. Schmalensee, S. Silbey

15.034 Data Analysis for Management
Prereq: None
G (Fall)
3-0-6
Enables students to understand and conduct careful empirical work using regression analysis as used in business fields such as finance, marketing and strategy, as well as in general business planning and forecasting. Emphasizes model formulation, intuition, and critical evaluation of results. Learning is primarily through empirical work done by student groups; delivered through problem sets, short write-ups, presentations and debates.
R. Rigobon, T. Stoker

15.040 Special Seminar in Managerial Economics
Prereq: 15.010, 15.012
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Group study of current topics related to managerial economics not otherwise included in curriculum.
T. M. Stoker

15.053 Optimization Methods in Management Science
Prereq: None
U (Spring)
4-0-8
Introduces students to the theory, algorithms, and applications of optimization. The optimization methodologies include linear programming, network optimization, integer programming, and decision trees. Applications to logistics, manufacturing, transportation, marketing, project management, and finance.
J. B. Orlin

15.054J The Airline Industry
(Same subject as 1.232J, 16.71J, ESD.217J)
Prereq: None
G (Fall)
3-0-9
See description under subject 16.71J.

15.060 Data, Models, and Decisions
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Introduces students to the basic tools in using data to make informed management decisions. Covers introductory probability, decision analysis, basic statistics, regression, simulation, linear and nonlinear optimization, and discrete optimization. Computer spreadsheet exercises, cases, and examples drawn from marketing, finance, operations management, and other management functions. Restricted to first-year Sloan master's students.
D. Bertsimas, R. Freund, G. Perakis, A. S. Schulz

15.062J Data Mining: Finding the Data and Models that Create Value
(Same subject as ESD.754J)
Prereq: 15.060, 15.074, or 15.075
G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
Introduction to a class of methods known as data mining or machine learning that assist managers in recognizing patterns and making intelligent use of massive amounts of electronic data collected via the internet, e-commerce, electronic banking, point-of-sale devices, barcode readers, and intelligent machines. Topics selected from logistic regression; association rules; tree-structured classification and regression; cluster analysis; discriminant analysis;
and neural network methods. Examples of successful applications in areas such as credit ratings, fraud detection, marketing, customer relationship management, investments, and logistics are covered. Introduction to data-mining software.

R. Welsch

15.063 Communicating with Data
Prereq: Permission of instructor
G (Summer)
3-0-6 H-LEVEL Grad Credit

Introduces statistical tools and communication skills for using data to influence management decisions. In real-life decisions, decision makers use both analytical and intuitive approaches to understand problems and to persuade others to act. Statistical tools are important, but statistical arguments are often met with skepticism. Subject covers decision analysis, communication principles, probability, testing theories, statistical sampling and regression, and misuses of statistics, with exercises and examples drawn from marketing, finance, operations management, strategy, and law. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.

A. Barnett

15.064j Engineering Probability and Statistics
(Same subject as ESD.751J)
Prereq: Calculus II (GIR)
G (Summer)
4-0-8 H-LEVEL Grad Credit

Modeling and analysis of uncertainty and variation. Probability models and distributions, regression, and basic statistical procedures pertinent to manufacturing and operations. Introduction to experimental and robust design, statistical process control, and forecasting. Use of a data analysis package such as JMP or Minitab. Primarily for Leaders for Global Operations students.

A. I. Barnett, R. Welsch

15.066j System Optimization and Analysis for Manufacturing
(Same subject as 2.851J, ESD.750J)
Prereq: Calculus II (GIR)
G (Summer)
4-0-8 H-LEVEL Grad Credit

Introduction to mathematical modeling, optimization, and simulation, as applied to manufacturing. Specific methods include linear programming, network flow problems, integer and nonlinear programming, discrete-event simulation, heuristics and computer applications for manufacturing processes and systems.

R. Welsch

15.067 Competitive Decision-Making and Negotiation
Prereq: None
G (Fall, Spring; partial term)
3-0-3

Learn tools to achieve negotiation objectives fairly and responsibly. Negotiation skills developed by active participation in a variety of negotiation settings: an oil price (repetitive Prisoners’ Dilemma) negotiation; fair division of a valuable art collection and a series of integrative bargaining cases between two and more than two parties over multiple issues; e.g. owners of an online vendor of mid-priced wines negotiates sale of the company to a large chain; two companies negotiate an IT deal. Several complex team negotiations follow. Grades depend solely on effective negotiation with class counterparts. Students must complete all negotiation exercises in order to receive a grade.

G. M. Kaufman

15.068 Statistical Consulting
Prereq: 15.060
G (Spring)
3-0-6 H-LEVEL Grad Credit

Addresses statistical issues as a consultant would face them: deciphering the client’s question; finding appropriate data; performing a viable analysis; and presenting the results in compelling ways. Real-life cases and examples.

A. I. Barnett

15.070j Advanced Stochastic Processes
(Same subject as 6.265J)
Prereq: 6.431, 15.085J, or 18.100
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Analysis and modeling of stochastic processes. Topics include measure theoretic probability, martingales, filtration, and stopping theorems; elements of large deviations theory; Brownian motion and reflected Brownian motion; stochastic integration and Ito calculus; functional limit theorems. Applications to finance theory, insurance, queuing and inventory models.

D. Gamarnik, D. Shah

15.071 the edge: decision methodologies for managers
Prereq: 15.053 or 15.060
G (Spring)
3-0-6 H-LEVEL Grad Credit

Presents real world examples, in which quantitative methods provide a significant competitive edge that has led to a first order impact on a variety of some of today's most important companies. Examples include: finance (quantitative asset management and options pricing), sports, health care, revenue management, supply chains, and the internet. The class outlines the competitive landscape, presents the key quantitative methods that created the edge (data mining, dynamic optimization, simulation), and discusses the impact of these methods. Team projects.

D. Bertsimas

15.072j Queues: Theory and Applications
(Same subject as 6.264J)
Prereq: 6.262
G (Spring)
3-0-9 H-LEVEL Grad Credit

Modeling and analysis of queueing systems, with applications in communications, manufacturing, computers, call centers, service industries and transportation. Topics include birth-death processes and simple Markovian queues, networks of queues and product form networks, single and multi-server queues, multi-class queueing networks, fluid models, adversarial queueing networks, heavy-traffic theory and diffusion approximations. Covers state of the art results which lead to research opportunities.

D. Bertsimas, D. Gamarnik, J. N. Tsitsiklis

15.073j Logistical and Transportation Planning Methods
(Same subject as 1.203J, 6.281J, 16.76J, ESD.216J)
Prereq: 6.041
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 1.203).


15.074j Statistical Reasoning and Data Modeling
(Same subject as ESD.755J)
Prereq: 6.041, 15.060, or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

Designed for students who have some acquaintance with probability and/or statistics and want exposure to a wider range of topics and exam-
Table of Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.075</td>
<td>Statistical Thinking and Data Analysis</td>
<td>R. E. Welsch</td>
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<tr>
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<td>Prereq: 6.041 or Coreq: 18.440</td>
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<td>U (Fall) 4-0-8</td>
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<tr>
<td></td>
<td>Introduces statistical data analysis, concentrating on</td>
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<td>techniques used in management science and finance.</td>
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<td>Topics chosen from applied probability, sampling,</td>
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<td>estimation, hypothesis testing, linear and logistic</td>
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<td>regression, analysis of variance, categorical data</td>
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<td>analysis, and misuses of statistics.</td>
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<tr>
<td></td>
<td>A. I. Barnett</td>
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<tr>
<td>15.077</td>
<td>Statistical Learning and Data Mining</td>
<td>R. E. Welsch</td>
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<td>(Same subject as ESD.753))</td>
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<td>Prereq: 6.431, 15.085), or 18.440; 18.06 or 18.700</td>
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<td>G (Spring) 4-0-8 H-LEVEL Grad Credit</td>
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<tr>
<td></td>
<td>Advanced introduction to the theory and application of</td>
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<td>statistics and data mining, concentrating on techniques</td>
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<td></td>
<td>used in management science, finance, consulting,</td>
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<td></td>
<td>engineering systems, and bioinformatics. First half builds</td>
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<td>the statistical foundation for the second half which</td>
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<td>concentrates on data-mining, supervised learning, and</td>
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<td>multivariate analysis. First half topics selected from</td>
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<td>sampling, theory of estimation, testing, nonparametric</td>
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<td>statistics, analysis of variance, categorical data</td>
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<td>analysis, regression analysis, MCMC, EM, Gibbs sampling,</td>
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<td>hidden Markov models, and Bayesian methods. Second half</td>
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<td>topics selected from logistic regression; principal</td>
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<td>components and dimension reduction; discrimination and</td>
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<td>classification analysis including trees (CART), partial</td>
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<td>least squares, nearest neighbor and regularized methods,</td>
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<td>support vector machines, boosting and bagging,</td>
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<td>clustering, independent component analysis, and</td>
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<td>nonparametric regression. R, S+, MATLAB, SAS, or similar</td>
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<td>statistics package used for data analysis and data</td>
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<td>mining.</td>
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<td>R. E. Welsch</td>
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<tr>
<td>15.078</td>
<td>Models, Data and Inference for Socio-Technical Systems</td>
<td>R. E. Welsch</td>
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<tr>
<td></td>
<td>(New)</td>
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<td></td>
<td>(Same subject as ESD.86J)</td>
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<tr>
<td></td>
<td>Prereq: ESD.83, 6.041, or permission of instructor</td>
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<td>G (Spring) 3-0-9</td>
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<tr>
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<td>See description under ESD.86J.</td>
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<tr>
<td></td>
<td>R. Larson, R. Welsch</td>
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<tr>
<td>15.081</td>
<td>Introduction to Mathematical Programming</td>
<td>R. E. Welsch</td>
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<td>(Same subject as 6.251J)</td>
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<td>Prereq: 18.06</td>
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<td>G (Fall) 4-0-8 H-LEVEL Grad Credit</td>
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<td>See description under subject 6.251J.</td>
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<td>J. N. Tsitsiklis, D. Bertsimas</td>
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<tr>
<td>15.082</td>
<td>Network Optimization</td>
<td>R. E. Welsch</td>
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<tr>
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<td>(Same subject as 6.855I, ESD.78B)</td>
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<tr>
<td></td>
<td>Prereq: 6.046I, 6.251J, 15.081I, or permission of</td>
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<td>instructor</td>
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<td>Acad Year 2009–2010: Not offered</td>
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<td>Acad Year 2010–2011: G (Spring)</td>
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<td>3-0-9 H-LEVEL Grad Credit</td>
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<tr>
<td></td>
<td>Network models for industrial logistics systems,</td>
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<td>transportation systems, communication systems, and other</td>
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<td>applications. Emphasizes a rigorous treatment of</td>
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<td></td>
<td>algorithms and their efficiency. Algorithms for shortest</td>
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<td></td>
<td>paths, maximum flow, minimum cost flows, traffic</td>
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<td>equilibrium, and network design. Implementation issues.</td>
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<td></td>
<td>A. S. Schul</td>
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<tr>
<td>15.083</td>
<td>Integer Programming and Combinatorial Optimization</td>
<td>R. E. Welsch</td>
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<tr>
<td></td>
<td>(Same subject as 6.859I)</td>
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<td></td>
<td>Prereq: 15.081J or permission of instructor</td>
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<td>Acad Year 2009–2010: G (Fall)</td>
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<td>Acad Year 2010–2011: Not offered</td>
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<td>3-0-9 H-LEVEL Grad Credit</td>
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<td></td>
<td>In-depth treatment of the modern theory of integer</td>
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<td></td>
<td>programming and combinatorial optimization, emphasizing</td>
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<td></td>
<td>geometry, duality and algorithms. Topics include</td>
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<td>formulating problems in integer variables, enhancement</td>
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<td>of formulations, integer programming duality, linear</td>
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<td>and semidefinite relaxations, lattices and their</td>
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<td></td>
<td>applications, the geometry of integer programming,</td>
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<td>primal methods, cutting plane methods, connections with</td>
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<td>algebraic geometry, computational complexity,</td>
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<td>approximation algorithms, heuristic and enumerative</td>
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<td>algorithms, mixed integer programming and solutions of</td>
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<td>large scale problems.</td>
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<td>D. J. Bertsimas, A. S. Schul</td>
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<tr>
<td>15.084</td>
<td>Nonlinear Programming</td>
<td>R. M. Freund</td>
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<tr>
<td></td>
<td>(Same subject as 6.252I)</td>
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<td></td>
<td>Prereq: 18.06, 18.100</td>
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<td>G (Spring) 3-0-9 H-LEVEL Grad Credit</td>
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<td></td>
<td>See description under subject 6.252I.</td>
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<tr>
<td></td>
<td>R. M. Freund, D. P. Bertsekas, G. Perakis</td>
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<tr>
<td>15.085</td>
<td>Fundamentals of Probability</td>
<td>R. M. Freund</td>
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<tr>
<td></td>
<td>(Same subject as 6.436J)</td>
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<td></td>
<td>Prereq: Calculus II (GIR)</td>
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<td>G (Fall) 4-0-8 H-LEVEL Grad Credit</td>
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<td></td>
<td>See description under subject 6.436J.</td>
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<td></td>
<td>J. N. Tsitsiklis, D. Bertsimas</td>
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<tr>
<td>15.093</td>
<td>Optimization Methods</td>
<td>R. M. Freund</td>
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<tr>
<td></td>
<td>(Same subject as 6.255J)</td>
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<td></td>
<td>Prereq: 18.06</td>
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<td>G (Fall) 4-0-8 H-LEVEL Grad Credit</td>
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<td></td>
<td>Introduces the principal algorithms for linear,</td>
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<td>network, discrete, nonlinear, dynamic optimization and</td>
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<td></td>
<td>optimal control. Emphasis on methodology and the</td>
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<td>underlying mathematical structures. Topics include the</td>
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<td>simplex method, network flow methods, branch and</td>
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<td>cutting plane methods for discrete optimization,</td>
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<td>optimality conditions for nonlinear optimization,</td>
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<td>interior point methods for convex optimization,</td>
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<td>Newton’s method, heuristic methods, and dynamic</td>
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<td>programming and optimal control methods.</td>
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<td>D. Bertsimas, P. Parrilo</td>
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<tr>
<td>15.094</td>
<td>Systems Optimization: Models and Computation</td>
<td>R. M. Freund</td>
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<tr>
<td></td>
<td>(Same subject as 1.142J)</td>
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<td></td>
<td>Prereq: 18.06 or permission of instructor</td>
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<td>G (Spring) 4-0-8 H-LEVEL Grad Credit</td>
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<td></td>
<td>A computational and application-oriented introduction to</td>
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<td>optimization modeling of large-scale systems using</td>
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<td>state-of-the-art optimization algorithms and software.</td>
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<td>Model formulation and solution techniques include linear,</td>
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<td>nonlinear convex, and non-convex optimization, discrete</td>
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<td>optimization, and semidefinite optimization. Application</td>
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<tr>
<td></td>
<td>domains include transportation, telecommunications,</td>
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<td>pattern classification, structural and engineering</td>
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<td>design, and financial engineering. Students develop</td>
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<td>formulation and solution skills in homework assignments,</td>
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<td>and formulate and solve a problem aligned with their</td>
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<td>interests in a final project.</td>
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<td>R. M. Freund</td>
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</table>
15.097 Special Seminar in OR/Statistics
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Group study of current topics related to operations research/statistics not otherwise included in the curriculum.
G. Perakis, A. S. Schulz

15.098 Special Seminar in Applied Probability and Stochastic Processes
Prereq: 6.431
G (Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Doctoral student seminar covering current topics in applied probability and stochastic processes.
D. Gamarnik, D. Shah

15.099 Special Seminar in Operations Research
Prereq: 15.081J
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Doctoral student seminar covering current topics related to operations research not otherwise included in the curriculum.
D. Bertsimas, R. Freund, T. L. Magnanti, J. B. Orlin, G. Perakis, A. S. Schulz

Civil and Environmental Engineering: 1.151, 1.155, 1.202, 1.203J, and 1.205

Electrical Engineering and Computer Science: 6.041, 6.231, 6.245, 6.262, 6.431, and 6.435

Management: 15.034, 15.070, 15.075, and 15.098

Mathematics: 18.05, 18.175, 18.177, 18.440, 18.443, 18.445, 18.446, and 18.465
See also: 2.830, 5.70, 5.72, 7.02, 8.044, 8.08, 10.816, 11.220, 11.221, 16.322, 22.38, HST.191, and MAS.622]

Health Care Management

15.121J Clinical Trials in Biomedical Enterprise
(Same subject as HST.975J)
Prereq: None
G (Fall)
2-0-4
See description under subject HST.975J.
H. Golub

15.122J Critical Reading and Technical Assessment of Biomedical Information
(Same subject as HST.977J)
Prereq: SB degree in Biological Science or permission of instructor
G (Spring; first half of term)
1-0-2 H-LEVEL Grad Credit
See description under subject HST.977J.
S. Lapidus, S. Sengupta

15.123J Dynamics of Biomedical Technologies
(Same subject as HST.979J)
Prereq: None
G (Fall, Spring)
2-0-1 [P/D/F]
Can be repeated for credit
See description under subject HST.979J.
R. Cohen, T. Dagi, C. Berke

15.124J Evaluating a Biomedical Business Concept
(Same subject as HST.973J)
Prereq: HST.971
G (Spring)
1-0-2 H-LEVEL Grad Credit
See description under subject HST.973J.
R. J. Cohen, T. Dagi, C. Berke, E. Cannon

15.126J The Legal Framework of Biomedical Enterprise
(Same subject as HST.932J)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
2-0-3
See description under subject HST.932J.
J. Akula

15.127J Designing and Sustaining Technology Innovation for Global Health Practice
(Same subject as HST.939J)
Prereq: None
G (Spring)
Units arranged
See description under subject HST.939J.
U. Demirci, J. Blander

15.128J Neurotechnology Ventures
(Same subject as 9.455J, 20.454J, MAS.883J)
Prereq: None
G (Fall)
2-0-7 H-LEVEL Grad Credit
See description under subject MAS.883J.
E. S. Boyden, R. Ellis-Behnke, J. Bonsen

15.136J Principles and Practice of Drug Development
(Same subject as 7.547J, 10.547J, ESD.691J, HST.920J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Description and critical assessment of the major issues and stages of developing a pharmaceutical or biopharmaceutical. Drug discovery, preclinical development, clinical investigation, manufacturing and regulatory issues considered for small and large molecules. Economic and financial considerations of the drug development process. Multidisciplinary perspective from faculty in clinical; life; and management sciences; as well as industry guests.
T. J. Allen, C. L. Cooney, S. N. Finkelstein, R. H. Rubin, A. J. Sinskey

15.137J Case Studies and Strategies in Drug Discovery and Development
(Same subject as 7.549J, 20.486J, HST.916J)
Prereq: Permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit
See description under subject 20.486J.
S. R. Tannenbaum, A. J. Sinskey, E. Berndt

15.141J Economics of the Health Care Industries
(Same subject as HST.918J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Focuses on economic issues in various health care and allied industries, such as the pharmaceutical, biotech, medical device, vaccine and diagnostic fields. Addresses differences between health care and other industries; regulatory issues involving establishing efficacy and cost-effectiveness of treatments; managing those who manage R&D; policies to incentivize R&D for diseases highly prevalent in poor countries; strategic issues in global pricing and marketing; use of e-commerce and information technology; and formation and management of various alliances. Visiting speakers from academia, government, and industry.
E. R. Berndt
global economics & management

15.220 Global Strategy and Organization
Prereq: Permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit
Focuses on the international dimensions of strategy and organization, and provides a framework for formulating strategies in an increasingly complex world economy, and for making those strategies work effectively. Topics include the globalization of industries, the changing role of country factors in competition, organization of multinational enterprises, building global networks, and the changing managerial tasks under conditions of globalization. 15.012 and 15.223 are highly recommended. Half-term subject.
D. Lessard, E. Obukhova

15.223 Global Markets, National Policies and the Competitive Advantages of Firms
Prereq: Permission of instructor
G (Fall, Spring, Summer)
3-0-3 H-LEVEL Grad Credit
Examines opportunities and risks firms face in today’s global market. Provides conceptual tools for analyzing how governments and social institutions influence economic competition among firms embedded in different national settings. Public policies and institutions that shape competitive outcomes are examined through cases and analytical readings on different companies and industries operating in both developed and emerging markets. Undergraduates may register for this subject provided they are ready to participate with the intensity expected for a grad H-level subject. 15.012 is highly recommended. Half-term subject.
S. Johnson, E. Obukhova

15.225 Economy and Business in Modern China and India
Prereq: None
G (Spring)
3-0-3
As markets or production bases, China and India are becoming important and integral players in the global economy. Foreign direct investment (FDI), portfolio investments and outsourcing businesses have increased dramatically in these two economies. Despite the rising importance of these two economies on the world stage, our knowledge and analysis of these two countries in an integrated manner has remained poor. The two are often lumped together by business analysts as “emerging markets,” despite the substantial differences in their political systems, reform policies and business organizations. Academics, in contrast, have tended to treat two countries separately, preferring to specialize in issues and questions specific to one or the other country. The purpose of this course is to analyze these two countries within a coherent analytical framework. Our learning model is inductive, and heavily based on class discussions and participation. The group projects should aim at integrating analysis, knowledge and understanding of these two countries. We will also experiment with other forms of group projects, such as creating and working on business plans and those projects that integrate research from field trips with more traditional research (such as library research). There is no prerequisite but 15.012 and 15.223 are highly recommended. Half-term course.
Y. Huang

15.227–15.229 Special Seminars in International Management
Prereq: None
G (Fall, Spring)
Can be repeated for credit
Group study of current topics related to international business not otherwise included in curriculum. Consult Y. Huang

15.249 Institutions, Society, and International Business
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
Units arranged
Can be repeated for credit
Advanced seminar in the study of international management. Covers major theoretical work and approaches to empirical research in the fields of national business systems and globalization, linking them to the core frameworks of strategy and organization theory. Restricted to doctoral students.
E. Obukhova

history, environment and ethics

15.268 Choice Points: Readings on the Exercise of Power and Responsibility
Prereq: None
G (Spring)
3-0-6
Prereq: Permission of instructor
Can be repeated for credit
Managers power and responsibility. Examines conflicts between power and moral responsibility and the contexts for choice in dealing with a number of such problems. Readings are principally “classics” used to illustrate several enduring issues. Restricted to Sloan Fellows in Innovation and Global Leadership. Consult S. Sacca

15.269 Literature, Ethics, and Authority
Prereq: None
G (Fall)
3-0-6
Explores how we use story to articulate ethical norms. The syllabus consists of short fiction, novels, plays, feature films and some non-fiction. Major topics include leadership and authority, professionalism, the universality of ethical standards, and social enterprise, as well as questions of gender, cultural and individual identity, the balance of family and work life, and the relation of science to ethics. Readings include work by Robert Bolt, Michael Frayn, Timothy Mo, Wole Soyinka, H.D. Thoreau, and others; films include Crouching Tiger, Hidden Dragon, Hotel Rwanda, Motorcycle Diaries, Three Kings, and others. Draws on various professions and national cultures, and is run as a series of moderated discussions, with students centrally engaged in the teaching process.
L. Hofrey

communication

15.270 Ethical Practice: Professionalism, Social Responsibility, and the Purpose of the Corporation
Prereq: None
G (Spring; partial term)
3-0-3
Introduction to ethics in business, with a focus on business management. Over thirteen sessions, students explore theoretical concepts in business ethics, and cases representing the challenges they will likely face as managers. Opportunity to work with guest faculty as well as business and other professional practitioners. Individual sessions take the form of moderated...
**15.277 Special Seminar in Communications**
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit

**15.278 Special Seminar in Communications**
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Group study of current topics related to communication not otherwise included in curriculum.
N. Hartman

**15.279 Management Communication for Undergraduates**
Prereq: None
U (Fall, Spring)
3-0-9

Required seminar for Management Science majors to develop the writing, speaking, teamwork, and interpersonal communication skills necessary for managers. Students learn communication principles, strategies, and methods through discussions, exercises, examples, and cases. Assignments include writing memos and business letters, and giving oral presentations in labs outside of class. A major project is the production of a team report and presentation on a topic of interest to a managerial audience. Priority given to Course 15 students.
L. Breslow

**15.280 Communication for Managers**
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

Writing and speaking skills necessary for a career in management. Students polish communication strategies and methods through discussion, examples, and practice. Several written and oral assignments, most based on material from other subjects and from career development activities. Schedule and curriculum coordinated with Organizational Processes class. Mandatory weekly one hour recitation in small groups. Restricted to first-year Sloan graduate students.
L. Hafrey, N. Hartman, T. Heagney, C. Kelly, R. Pittore, V. Healy-Tangney, K. Blackburn

**15.281 Advanced Managerial Communication**
Prereq: 15.279, 15.280, or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

Builds on managerial communication skills developed in 15.279 or 15.280. Introduces interactive oral and interpersonal communication skills important to managers, including presenting to a hostile audience, running meetings, listening, and contributing to group decision-making. Includes team-run classes on chosen communication topics. Also includes an executive summary and a long oral presentation, both aimed at a business audience, generally in conjunction with a project for another subject.
N. Hartman

**15.289 Doctoral Seminar: Communication Skills for Academics**
Prereq: Permission of instructor
G (Spring)
3-0-3 H-LEVEL Grad Credit

Focuses on the communication skills needed for a career in academia. Topics include writing letters and business correspondence, preparing and delivering conference papers and job talks, reviewing literature, and teaching. Participants are expected to work on a written project and deliver an oral presentation based on their current research. Restricted to doctoral students who have completed their first year. Enrollment limited to 20; priority to Sloan students.
J. Yates, L. Breslow

**15.301 Managerial Psychology Laboratory**
Prereq: None
U (Fall, Spring)
3-3-9 Institute LAB

Surveys individual and social psychology and organization theory interpreted in the context of the managerial environment. Laboratory involves projects of an applied nature in behavioral science. Emphasizes use of behavioral science research methods to test hypotheses concerning decision-making, group behavior, and organizational behavior. Instruction and practice in communication includes report writing, team projects, and oral and visual presentation. 12 units may be applied to the General Institute Laboratory Requirement.
Fall: J. Carroll, T. Kochan
Spring: P. Osterman

**15.305 Leadership and Management**
Prereq: Permission of instructor
U (Fall)
3-0-6

Explores leadership from the military perspective taught by professors of military science from the Army, Navy and Air Force. Survey of basic principles for successfully managing and leading people, particularly in public service and the military. Develops skills in topics such as oral and written communication techniques, planning, team building, motivation, ethics, decision-making, and managing change. Relies heavily on interactive experiential classes with case studies, student presentations, role plays, and discussion. Also appropriate for non-management science majors.
D. Ancona, M. Keller

**15.310 Managerial Psychology**
Prereq: None
G (Fall, Spring)
2-1-6

Surveys social psychology and organization theory interpreted in the context of the managerial environment. Shares lectures with 15.301, with a separate recitation required. Equivalent of 15.311 intended primarily for non-Course 15 students, both graduate and undergraduate. Deals with a number of diverse subjects, including motivation and reward systems, social influence, groups and teams, leadership, power, organizational design and culture, and networks and communication patterns in the organization.
J. Carroll

**15.311 Organizational Processes**
Prereq: Permission of instructor
G (Fall)
2-3-4 H-LEVEL Grad Credit

Enhances students’ ability to take effective action in complex organizational settings by providing the analytic tools needed to analyze, manage, and lead the organizations of the future. Emphasizes the importance of the organizational context in influencing which individual styles and skills are effective. Employs a wide variety of learning tools, from experiential learning to the more conventional discussion of written cases. Centers on three complementary perspectives on organizations: the strategic design, political, and cultural “lenses” on organizations. Major team project to analyze an actual organizational change, with oral and written reports. Restricted to first-year Sloan master’s students.
R. Reagans, K. Kellogg, D. Loyd
15.316 Building and Leading Effective Teams
Prereq: None
G (Summer)
2-1-0 [P/D/F]
An intensive one-week introduction to leadership, teams, and learning communities. Introduction of concepts and use of a variety of experiential exercises to develop individual and team skills and develop supportive relationships within the Fellows class. Restricted to first year LGO Fellows. Consult J. S. Carroll

15.317 Organizational Leadership and Change
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Course spans the entire two-year Leaders for Global Operations (LGO) program, focusing on practical experience that blends theory and practice. Students reflect on prior leadership experiences and then apply lessons learned to further develop their leadership capabilities. Requires active participation in all leadership classes and/or activities as well as short deliverables throughout the program.
T. A. Kochan, J. Klein

15.318 Leadership and Change in Organizations
Prereq: 15.311, 15.315, 15.322, or permission of instructor
Acad Year 2009–2010: G (Spring; first half of term)
Acad Year 2010–2011: Not offered
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Focuses on leadership and creating change and provides grounding in leadership theories and frameworks. Action-oriented, interactive sessions introduce the basic tools to lead change within organizations, regardless of one’s positional power. Students explore alternative approaches to leadership, compare and contrast various leadership styles, and look at a range of leadership tasks/processes.
D. Ancona

15.320 Strategic Organizational Design
Prereq: None
G (Spring)
3-0-6
Focuses on designing effective organizations, with emphasis on innovative organizational forms that can provide strategic advantage. Topics include creating new organizational possibilities with IT, democratic decision-making, prediction markets, internal and external resource markets, collective intelligence, and organizational invention techniques. Team projects include inventing new possibilities for real organizations.
T. Malone

15.322 Leading Organizations
Prereq: None
G (Fall, Summer)
4-0-5 [P/D/F]
Analyzes through lectures, discussions, and class exercises, the human processes underlying organizational behavior. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.
J. Van Maanen

15.325 Seminar in Leadership I
Prereq: None
G (Fall)
2-0-1 [P/D/F]
Provides students opportunities to meet senior executives of private and public institutions, and discuss key management issues from the perspective of top management. Students prepare detailed briefings identifying and analyzing important management issues facing these organizations. Seminar includes a one week field trip to a domestic location. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.
Consult S. Sacca

15.326 Seminar in Leadership II
Prereq: 15.325
G (Spring)
2-0-1 [P/D/F] H-LEVEL Grad Credit
Continuation of subject 15.325 on the identification and analysis of important management issues. Students prepare briefings and meet with senior government and international leaders during field trips in selected international areas. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.
S. Sacca

15.328 Special Seminar in Organization Studies
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Consult D. Ancona

15.341 Individuals, Groups, and Organizations
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Develops basic concepts for understanding individual, group, and organizational behavior through critical analysis of important works in the field. Areas covered: individual affect and cognition; group process and performance; and organizational culture and adaptation. Emphasizes use of behavioral science concepts for stimulating new and useful organizational behavior research. Primarily for doctoral candidates in the Sloan School of Management.
J. Carroll

15.342 Organizations and Environments
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Provides an introduction to research in “organizations and environments,” an interdisciplinary domain of inquiry drawing primarily from sociology, and secondarily from economics, psychology, and political science. Seeks to understand organizational processes and outcomes in the surrounding economic, cultural, and institutional context in which they are situated. Also provides an introduction to the main groups that together form the Behavioral Policy Sciences (BPS) area of MIT Sloan, including economic sociology, organization studies, work and employment, strategic management, global management, and technology, innovation, and entrepreneurship. Consists of four modules taught by faculty from each of the four BPS groups, as well as integrative sessions taught by the main instructor. Preference to first-year doctoral students in BPS.
E. Zuckerman

15.343 Managing Transformations in Work Organizations and Society (New)
Prereq: None
G (Spring)
3-0-6
Examines changing relations among work, organizations, and society and their implications for management and sustainability. Focuses on the skills managers need to build and lead sustainable organizations and to adapt to increasing workforce diversity; modular, dispersed and team-based work systems; and customer-employee interactions in a service-based economy. Discusses the role of the corporation in society, its responsibilities to multiple stakeholders, and interactions with community groups, labor market institutions, and national and global governmental bodies. Students conduct an
action-based research project in an organization of their choice.

T. Kochan

15.345 Doctoral Proseminar in Behavioral and Policy Sciences
Prereq: Permission of instructor
G (Fall)
2-0-4 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

A professional seminar for doctoral students to report on their research, work on their thesis proposals, and practice their job talks. Also addresses general professional issues such as publishing, searching for jobs, the academic career, etc.

L. Bailyn

15.347 Doctoral Seminar in Research Methods I
(Subject meets with 21A.861)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Introduces the process of social research, emphasizing the conceptualization of research choices to ensure validity, relevance, and discovery. Includes research design and techniques of data collection as well as issues in the understanding, analysis, and interpretation of data.

S. Silbey, A. McCants

15.348 Doctoral Seminar in Research Methods II
Prereq: 15.347 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

Builds on 15.347 to examine contemporary social research methods in depth. Focuses on making students familiar with the most important quantitative methods (e.g., logit/probit models, count models, event history models) or qualitative methods (e.g., ethnography, interviewing, participant observation).

E. J. Castilla

15.349 Qualitative Research Methods
(Same subject as 21A.760, STS.401J)
Prereq: None
G (Spring)
3-6-3

See description under subject 21A.760.

S. Silbey, E. C. James

TECHNOLOGY, INNOVATION AND ENTREPRENEURSHIP

15.350 Managing Technological Innovation and Entrepreneurship
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Focuses on the challenges inherent in attempting to take advantage of both incremental innovation and more radical or breakthrough changes in products, processes and services. Highlights the importance of innovation to both new ventures and to large established firms and explores the organizational, economic and strategic problems that must be tackled to ensure innovation is a long term source of competitive advantage. Discussions and class presentations cover non-technical as well as technology-based innovation. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.

M. A. Cusumano, E. B. Roberts

15.351 Managing Innovation and Entrepreneurship
Prereq: None
G (Spring)
3-0-6

The basics every manager needs to organize successful technology-driven innovation in both entrepreneurial and established firms. Examines innovation-based strategies as a source of competitive advantage and then examines how to build organizations that excel at identifying, building and commercializing technological innovations. Major topics include how the innovation process works; creating an organizational environment that rewards innovation and entrepreneurship; designing appropriate innovation processes (e.g. stage-gate, portfolio management); organizing to take advantage of internal and external sources of innovation; and structuring entrepreneurial and established organizations for effective innovation. Examines how entrepreneurs can shape their firms so that they continuously build and commercialize valuable innovations. Many of the examples also focus on how established firms can become more entrepreneurial in their approach to innovation.

F. Murray

15.352 Innovation in the Internet Age: Emerging Trends
Prereq: None
G (Spring)
3-0-3

Important emerging trends in innovation are identified and their implications for innovation management explored. Major topics include the trend to open information (open source) rather than protected intellectual property; distribution of innovation over many independent but collaborating actors; and toolkits that empower users to innovate for themselves. Half-term subject.

E. A. von Hippel

15.353 Research Themes in Management of Technology
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

Successful origination, development, implementation, and diffusion of product and process innovations in industry. Effective organization and management of the technological change process (marketing, R&D, engineering, and manufacturing) in new ventures, multidivisional and multinational enterprises. Current research topics of MIT faculty. Thesis research models and methods.

J. M. Utterback

15.354 Innovation and Entrepreneurship: How to Do It
Prereq: None
U (Spring)
3-0-6

Examines how to be a successful innovator in a big company and how to be an entrepreneur. Covers both internet-age and traditional businesses. Research findings are combined with practical advice from experienced innovators to help launch students on a successful innovation trajectory. Lecture-based course. Periodic, short projects enable students to explore topics of special interest to them independently or in small groups.

J. M. Utterback

15.355 Managing New Ventures
Prereq: Permission of instructor
G (Fall; second half of term)
3-0-3 H-LEVEL Grad Credit

Presents the main themes of managing innovation ventures in firms of varying size and establishment. First half develops an understanding of the issues involved in establishing and building new firms, including their potential benefits and limitations. Examines the different developmental patterns adopted by start-ups, many which involve linkages between new and established firms. Second half focuses on the problems established firms face in maintaining their competitiveness and growth. Discusses ways to make them behave more like smaller, nimbler organizations. Also covers ways to
expansions must develop major innovations to prosper but they don’t know how. Recent research into the innovation process has made it possible to develop breakthroughs systematically. Explore several practical ideas generation development methods. Presentations of real cases by invited experts convey the art required to implement each. Half-term subject.

E. A. von Hippel

15.356 How to Develop Breakthrough Products and Services
Prereq: None
G (Spring)
3-0-3

Firms must develop major innovations to prosper but they don’t know how. Recent research into the innovation process has made it possible to develop breakthroughs systematically. Explore several practical ideas generation development methods. Presentations of real cases by invited experts convey the art required to implement each. Half-term subject.

E. A. von Hippel

15.358 The Business of Software and Digital Platforms
Prereq: None
G (Spring)
3-0-6

Seminar-style course aimed at anyone interested in the business and technology sides of software and digital platforms, from enterprise and consumer software to mobile services and video games. Designed for students who want to find their own companies or work as project and product managers, industry analysts, or venture capitalists. Considers key strategic and technical concepts, with particular emphasis on product vs. services distinctions. Reviews how software became a business at IBM, Microsoft, and SAP; newer companies such as Google, and Salesforce.com; and start-ups. Students may analyze ongoing platform battlegrounds such as enterprise software, smart phones, Web 2.0, digital media, video game consoles, and internet-based advertising and media. Examines what is special about marketing, sales, product development, and entrepreneurship in the case of software and digital markets. Student teams help teach weekly sessions and analyze emerging companies and sectors in team projects. Practitioners help teach the class and offer some guest lectures.

M. A. Cusumano

15.360 Introduction to Technological Entrepreneurship
Prereq: Permission of instructor
G (Fall)
2-0-1 H-LEVEL Grad Credit

Overview of the field of entrepreneurial theory and practice for development and growth of technology-based new enterprises. Introduction to the MIT ecosystem of entrepreneurship. Weekly lectures and dinner discussion sessions by academic and practitioner faculty engaged in the MIT Entrepreneurship Program, supplemented by leaders of MIT entrepreneurship-related activities, e.g., Technology Licensing Office, Deshpande Center, Venture Mentoring Service, as well as successful entrepreneurs and venture capitalists. Student presentations and discussions of new business ideas. Restricted to students in Sloan MBA Entrepreneurship and Innovation track.

E. Roberts

15.362 Entrepreneurship Study Tour of Silicon Valley
Prereq: 15.360
G (IAP)
1-0-0 [P/D/F] H-LEVEL Grad Credit

Intensive one week group tour of Silicon Valley, focusing on understanding an entrepreneurial ecosystem. Visits to prominent venture capitalists and large numbers of primarily early-stage high-technology new ventures. Restricted to students in Sloan MBA Entrepreneurship and Innovation track.

K. Morse, E. Roberts

15.363 Strategic Decision Making in the Biomedical Business
Prereq: Same subject as HST.971J
G (Spring)
3-0-6

Key strategic decisions faced by managers, investors and scientists at each stage in the value chain of the life science industry. Aims to develop students’ ability to understand and effectively assess these strategic challenges. Focus on the biotech sector, with additional examples from the pharmaceutical and medical device sectors. Case studies, analytical models and detailed quantitative analysis. Intended for students interested in building a life science company or working in the sector as a manager, consultant, analyst or investor. Provides analytical background to the industry for biological and biomedical scientists, engineers and physicians with an interest in understanding the commercial dynamics of the life sciences or the commercial potential of their research.

J. M. Utterback

15.365 Disruptive Technologies: Predator or Prey?
Prereq: None
G (Spring)
3-0-6

Focuses on the management of product and process innovation and on economic, management, and technological influences on innovation. Both sustaining and disruptive innovations in products and manufacturing processes covered in lectures and cases presented by the leaders of change in different industries. Emphasis on emerging and disruptive technologies as seen from the points of view of entering firms (predators) and incumbent firms (prey) are covered in a class exercise, and project (preferably done in small groups).

W. Aulet, D. Lessard

15.366 Energy Ventures (New)
Prereq: 15.390 or 15.371; 10.391J or 10.579; or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Project-based subject focusing on energy sector companies. Explores how innovation and entrepreneurial concepts apply (or do not apply) to the significant opportunities in this quarter. Working in teams, students create new ventures specifically for the energy sector. Lectures guide teams through key elements of their projects. Concurrent enrollment in 15.933 recommended.

F. Murray

15.369 Corporate Entrepreneurship: Strategies for Technology-Based New Business Development
Prereq: 15.351, Coreq: 15.350
G (Fall)
2-0-4 H-LEVEL Grad Credit

Strategic and organizational issues in the development of new technologies and new business areas for existing firms. Issues examined from the perspectives of both large corporations and emerging technology-based enterprises. Linkages between internal and external sources of technology in major new business development. Examination of internal entrepreneurial ventures, alliances (especially between large and new companies), joint ventures, acquisitions, corporate venture capital investments, and licensing as alternative business development approaches. Covers aspects of corporate business development other than mergers and
acquisition (M&A) activities. Outside speakers supplement faculty lectures. Student teams prepare term reports on a competitive analysis of some aspect of corporate business development. Half-term subject.

E. B. Roberts

15.371J Innovation Teams
(Same subject as 10.807J)
Prereq: Permission of instructor
G (Fall, Spring)
4-4-4
Students work in teams to develop commercialization strategies for innovative research projects generated in MIT laboratories. Projects cover critical aspects of commercialization, from selecting the target application and market for the technology to developing an intellectual property strategy and performing a competitive analysis. Instruction provided in communication and teamwork skills, as well as analysis of the challenges and benefits of technology transfer. Includes lectures, guest speakers, and extensive team coaching. Designed primarily for students in engineering, science, and management. Applications, resumes, and a brief statement of interest are required prior to registration.

F. Murray, L. Perez-Breva

15.375J Development Ventures (New)
(Same subject as MAS.665J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject MAS.665J.

A. Pentland, J. Bonsen

15.376J Media Lab Enterprises: Digital Innovations (New)
(Same subject as MAS.664J)
Prereq: None
G (Spring)
3-0-6
Can be repeated for credit
See description under subject MAS.664J.

A. Pentland, J. Bonsen, F. Moss

15.380 Special Studies in Entrepreneurship
Prereq: Graduate student standing
G (Fall, IAP, Spring, Summer)
Units arranged
Advanced work or special investigation of an entrepreneurial topic not specifically covered elsewhere and not qualifying as a thesis. Readings, conferences, laboratory and fieldwork, and reports.

Consult Entrepreneurship Center Faculty

15.381 The Human Side of Technology
Prereq: Permission of instructor
G (IAP)
2-1-6
Examines the human side of managing technical professionals and teams throughout innovative processes, including micro and macro issues. Topics include motivational commitment and performance; dealing with complacency; understanding the relationships among innovation, change, motivation, and uncertainty; managing creative individual contributors; effective recognition and reward systems; leading decision making processes; staffing critical roles and cross-functional relationships; information/knowledge transfer; organizational diagnosis for change. Restricted to SDM students; others with permission of instructor.

Staff

15.385 Social Innovation and Entrepreneurship (New)
Prereq: None
G (Fall; first half of term)
3-0-3
Students work in teams to develop a feasibility plan for a social venture (either a for profit or nonprofit). Feasibility studies will integrate the marketing, financial, operational and organizational activities required to realize an opportunity. Examines the theory and practice of social innovation (e.g., business, environment, education, and human services) and entrepreneurship in the private, public and nonprofit sectors. Discussion topics include social impact modeling, social capital markets, and social impact assessment. Students gain practical knowledge on how to identify potential social venture opportunities; develop skills and competencies for creating, developing and implementing ideas; and examine ways to measure the success and value of social entrepreneurial activity.

A. Wolk

15.387 Technology Sales and Sales Management
Prereq: None
G (Fall, Spring)
3-0-3
Practical and tactical ins and outs of how to sell technical products to a sophisticated marketplace. How to build and manage a sales force; building compensation systems for a sales force, assigning territories, resolving disputes, and dealing with channel conflicts. Focus on selling to customers, whether through a direct salesforce, a channel salesforce, or building an OEM relationship. Half term course.

H. Anderson, P. Bell, K. Morse

15.388 Designing and Leading the Innovative Organization
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
2-0-4
Covers the building, running and growing of an organization. Subject has four central themes: how to think analytically about designing organizational systems; how leaders, especially founders, play a critical role in shaping an organization’s culture; what really needs to be done to build a successful organization for the long-term; and what can one do to improve the likelihood of personal success. Principles of organizational architecture, group behavior and performance, interpersonal influence, leadership and motivation. Through a series of cases, lectures, readings and exercises, students develop competencies in organizational design, human resources management, leadership and organizational behavior. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.

Staff

15.389 Global Entrepreneurship Lab: Emerging Markets
Prereq: None
G (Fall, IAP, Spring)
6-0-6
Enables teams of students to work with the top management of global start-ups and gain experience in starting and running a new enterprise outside the United States. Focuses on start-ups operating in various emerging markets. Lectures expose students to the issues and policies that affect the climate for innovation and start-up success around the world. Begins in Fall term and continues for three weeks during IAP, when students spend time at project sites. Concludes with poster session on GLAB day at beginning of the Spring term. Students must complete all
three components to receive credit. Restricted to graduate students.

**Staff**

**15.390 New Enterprises**
Prereq: None  
G (Fall, Spring)  
2-1-6

Covers the process of identifying and quantifying market opportunities, then conceptualizing, planning, and starting a new, technology-based enterprise. Topics include opportunity assessment, the value proposition, the entrepreneur, legal issues, entrepreneurial ethics, the business plan, the founding team, seeking customers and raising funds. Students develop detailed business plans for a start-up. Intended for students who want to start their own business, further develop an existing business, be a member of a management team in a new enterprise, or better understand the entrepreneur and the entrepreneurial process.

*N. Al Feyan, H. Anderson, K. Zolot*

**15.391 Early Stage Capital**
Prereq: Permission of instructor  
G (Fall)  
3-0-3 H-LEVEL Grad Credit

Focuses on the strategy as well as the tactics involved in negotiating and building effective, long-term relationships with investors, particularly venture capitalists, in an extremely difficult funding environment. Other topics include an introduction to understanding venture capital as a business; an introduction to search funds; the legal framework of the investment process and its related jargon; market practice and standards for term sheet negotiation; and strategies in identifying the optimal form of early stage capital. Coursework is team-centered: in two rounds of simulations, student teams assume the roles of founders of a start-up and first meet with practicing lawyers to gain advice and practical experience working with professional advisers. Teams then negotiate final terms of investment for their company with leading local VCs. Simulations are outside of class, off-campus at lawyers’ and VCs’ offices.

*S. Loessberg*

**15.394 Designing and Leading the Entrepreneurial Organization**
Prereq: Permission of instructor  
G (Spring)  
3-0-6 H-LEVEL Grad Credit

This subject is about building, running, and growing an organization. Subject has four central themes: (1) How to think analytically about designing organizational systems, (2) how leaders, especially founders, play a critical role in shaping an organization’s culture, (3) what really needs to be done to build a successful organization for the long-term; and (4) what one can do to improve the likelihood of personal success. Not a survey of entrepreneurship or leadership; subject addresses the principles of organizational architecture, group behavior and performance, interpersonal influence, leadership and motivation in entrepreneurial settings. Through a series of cases, lectures, readings and exercises students develop competencies in organizational design, human resources management, leadership and organizational behavior in the context of a new, small firm.

**Staff**

**15.396 Special Seminar in Entrepreneurship**
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged

Group study of current topics related to entrepreneurship not otherwise included in the curriculum.

*K. Morse*

**15.397 Special Seminar in Entrepreneurship**
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit

Individual or group study of current topics related to high tech entrepreneurship not otherwise included in the curriculum.

*K. Morse*

**15.398 Corporations at the Crossroads: The CEO Perspective**
Prereq: None  
G (Spring)  
2-0-4

Focus is on the role of the CEO. Students learn from some of the world’s leading CEOs who are invited to speak in the class. Topics include the job of the CEO, corporate strategy, and career learnings and advice. Particular emphasis on how the CEO is reacting to the crossroads where he currently finds his company. Sessions are highly interactive, with questions from the students. Before each class, a small group of students has dinner with the guest CEO, a truly unique experience for the students.

*H. Anderson, P. Kurzina*

**15.399 Entrepreneurship Lab**
Prereq: None  
G (Fall, Spring)  
2-9-1

Teams of science, engineering, and management students participate actively one day a week on-site with the top management of high tech start-ups in order to gain experience in starting and running a new venture. Student projects focus on one urgent aspect of the start-up, such as selection of target market, design of market-entry strategy, choice of sales approach to initial customers, etc. In addition to the regular MIT registration process, students should register at the course website one month before class to facilitate formation of student teams and matching of teams with potential host companies. Restricted to graduate students.

*Consult R. Bohn, K. Morse, J. Preston*

See also 15.136.

**FINANCE**

**15.401 Finance Theory I**
Prereq: None  
G (Fall, Spring)  
4-0-5

Core theory of modern financial economics and financial management, concentrating on capital markets and investments. Required prerequisite for most finance electives and for the Financial Management and Financial Engineering tracks. Topics: functions of capital markets and financial intermediaries; fixed income investments; diversification and portfolio selection; valuation theory and equilibrium pricing of risky assets; the theory of efficient markets; and an introduction to derivatives.

*J. Wang, H. Chen, S. Joslin*

**15.402 Finance Theory II**
Prereq: 15.401  
G (Fall, Spring)  
3-0-6 H-LEVEL Grad Credit

Continuation of 15.401, concentrating on corporate financial management. Topics include capital budgeting, investment decisions and valuation; working capital management, security issues; dividend policy; optimal capital structure; and real options analysis.

*P. Asquith, N. Bergman, C. Frydman*
15.403 Introduction to the Practice of Finance (New)
Prereq: None
G (Fall)
2-0-1 [P/D/F]
Proseminar exposes students to some of the basic institutions and practices of the financial industry. Includes panel discussions with representatives from leading financial institutions, MIT alumni currently engaged in the financial services sector, and leading industry vendors. Preference to first-year Finance track MBA students.
Staff

15.414 Financial Management
Prereq: 15.511
G (Summer)
3-0-6 H-LEVEL Grad Credit
Introduction to corporate finance and capital markets. Topics include project and company valuation, real options, measuring risk and return, stock pricing and the performance of trading strategies, corporate financing policy, the cost of capital, and risk management. Subject provides a broad overview of both theory and practice. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.
A. Lo

15.415 Finance Theory (New)
Prereq: 14.01 or 15.011; 15.501 or 15.515
G (Summer)
6-0-9 H-LEVEL Grad Credit
Core theory of capital markets and corporate finance. Topics include functions and operations of capital markets, analysis of consumption-investment decisions of investors, valuation theory, financial securities, risk analysis, portfolio theory, pricing models of risky assets, theory of efficient markets, as well as investment, financing and risk management decisions of firms. Provides a theoretical foundation of finance and its applications. Restricted to students in the Master of Finance Program.
Staff

15.416J Introduction to Financial Economics
(Same subject as 14.416J)
Prereq: 14.121, 14.122
G (Fall)
4-0-8 H-LEVEL Grad Credit
Foundations of modern financial economics; individuals’ consumption and portfolio decisions under uncertainty; valuation of financial securities. Topics include expected utility theory; stochastic dominance; mutual fund separation; portfolio frontiers; capital asset pricing model; arbitrage pricing theory; Arrow-Debreu economies; consumption and portfolio decisions; spanning; options; market imperfections; no-trade theorems; rational expectations; financial signaling. Primarily for doctoral students in accounting, economics, and finance.
S. A. Ross

15.419 Practice of Finance: Private Equity and Hedge Funds (New)
Prereq: None
G (Spring; second half of term)
2-0-1 [P/D/F]
Introduction to the field of alternative investments—principally private equity and hedge funds—within the context of the larger investment domain. Covers the structure and operation of alternative funds, valuation, and topics such as deal sourcing, exits, value added, and alpha strategies. Discusses the evolution of the field as well as what the future may bring. Summarizes subfields such as venture capital, leveraged buyouts, distressed investing, and the spectrum of hedge funds. Addresses investor perspectives, portfolio construction and risk management with alternatives. Encourages active student participation, and includes a project and reading list.
P. Cooper

15.420 Practice of Finance: International Financial Management (New)
Prereq: None
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Uses case studies and current events discussion to review the applications of international finance that impact social issues. Topics include multinational enterprises, international trade, international activities of domestic firms, foreign competition, and foreign exchange risks.
C. Kane

15.423 Practice of Finance: Advanced Corporate Risk Management (New)
Prereq: None
G (Spring)
2-0-0
Focuses on how corporations make use of the insights and tools of risk management. Taught from the perspective of potential end-users of derivatives (not the dealer), such as manufacturing corporations, utilities, and software firms. Topics include how companies manage risk, instruments for hedging, liability management and organization, and governance and control.
J. Parsons

15.426J Real Estate Finance and Investment
(Same subject as 11.431J)
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 11.431J.
Staff

15.427J Real Estate Capital Markets
(Same subject as 11.432J)
Prereq: 11.431J, 15.401, 15.402, or 15.414
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
See description under subject 11.432J.
D. Geltner

15.428J Tools for Analysis: Design for Real Estate and Infrastructure Development
(Same subject as 11.434J, ESD.712J)
Prereq: None
G (Spring; second half of term)
2-0-4
See description under subject 11.434J.
D. Geltner, R. de Neufville

15.431 Entrepreneurial Finance
Prereq: 15.402 or 15.414
G (Spring)
3-0-6 H-LEVEL Grad Credit
Examines the elements of entrepreneurial finance, focusing on technology-based start-up ventures, and the early stages of company development. Addresses key questions which challenge all entrepreneurs: how much money can and should be raised; when should it be raised and from whom; what is a reasonable valuation of the company; and how funding, employment contracts and exit decisions should be structured. Aims to prepare students for these decisions, both as entrepreneurs and venture capitalists. In-depth analysis of the structure of the private equity industry.
A. Schoar

15.433 Investments
Prereq: 15.401 or 15.414
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Financial theory and empirical evidence for making investment decisions. Topics include: portfolio theory; equilibrium models of security prices (including the capital asset pricing model and the arbitrage pricing theory); the empirical behavior of security prices; market efficiency; performance evaluation; and behavioral finance.
Enrollment priority is given to Course 15 students.

J. Pan

15.434 Advanced Corporate Finance
Prereq: 15.402, 15.411, or 15.414
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Advanced topics in corporate finance including complex valuations, static and dynamic capital structure, risk management, and real options. Considers the asymmetric information and incentive problems, security design, restructuring, bankruptcy, and corporate control and governance issues.
Faculty

15.437 Options and Futures Markets
Prereq: 15.401 or 15.414
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Examines the economic role of options and futures markets. Topics: determinants of forward and futures prices, hedging and synthetic asset creation with futures, uses of options in investment strategies, relation between puts and calls, option valuation using binomial trees and Monte Carlo simulation, implied binomial trees, advanced hedging techniques, exotic options, applications to corporate securities and other financial instruments.
Consult J. C. Cox

15.440 Advanced Financial Economics I
(Same subject as 14.440)
Prereq: 15.416
G (Spring)
3-0-9 H-LEVEL Grad Credit
Covers advanced topics in the theory of financial markets with a focus on continuous time models. Topics include multiperiod securities markets and martingales; pricing of contingent securities such as options; optimal consumption and portfolio problems of an individual; dynamic equilibrium theory and the intertemporal capital asset pricing model; term structure of interest rates; and equilibrium with asymmetric information, transaction costs, and borrowing constraints. Primarily for doctoral students in accounting, economics, and finance.
L. Kogan

15.441 Advanced Financial Economics II
(Same subject as 14.441)
Prereq: 14.121, 14.122, or 15.416
G (Spring)
3-0-9 H-LEVEL Grad Credit
Surveys selected topics in current advanced research in corporate finance. Theoretical and empirical analyses of corporate financing and investment decisions. Some background in information economics and game theory is useful. Primarily for doctoral students in accounting, economics, and finance.
S. Myers, A. Schoar

15.442 Advanced Financial Economics III
(Same subject as 14.442)
Prereq: 14.382, 15.416, or permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Recent empirical methods in finance, including: the estimation and testing of market efficiency; the random walk hypothesis; the CAPM/APT; various term structure models; option pricing theories; and market microstructures; performance evaluation; bond rating and default analysis; event study methodology; continuous-time econometrics; and general time series methods. An empirical term project is required. Some econometric background and rudimentary computer programming skills are assumed. Primarily for doctoral students in finance, accounting, and economics.
J. Pan

15.448–15.449 Special Seminar in Finance
Prereq: 15.402 or 15.414
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Group study of current topics related to finance not otherwise included in curriculum.
J. C. Cox

15.450 Analytics of Finance (New)
Prereq: 15.401
G (Spring)
3-0-6 H-LEVEL Grad Credit
Covers the key quantitative methods of financial engineering and computational finance: static and dynamic optimization; Monte Carlo simulation; stochastic (Itô) calculus; financial econometrics; and statistical inference for financial applications. Each of these techniques will be covered in depth—along with their computer implementation—however, emphasis is on financial-engineering applications, not on methodology. Develops quantitative methods within the context of specific problems in financial engineering that fall into one of the following areas: derivatives, portfolio management, risk management, or proprietary trading.
L. Kogan

15.451 Proseminar in Financial Engineering
Prereq: 15.401 or 15.414; 15.437
G (Fall)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Provides students a unique opportunity to tackle original research problems in financial engineering that have been posed by leading experts from the financial community. Students are assigned to teams and each team is assigned one such problem. The team’s solution is then presented at a seminar which is attended by representatives of the sponsoring organization and open to the entire MIT community.
M. Kritzman

15.452 Proseminar in Financial Management
Prereq: 15.402 or 15.414
G (Fall)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
The proseminar has two principal goals: to bridge the gap between finance theory and finance practice; and to introduce students to the broader financial community. Students participate in a series of proseminars with industry guest speakers. Each guest, in collaboration with finance faculty, provides a problem and materials to a team of students. Each team then prepares a report and presents their analysis to the guest speaker and other students for evaluation and feedback.
C. Holderness

ACCOUNTING

15.501 Corporate Financial Accounting
(Subject meets with 15.516)
Prereq: None
U (Fall, Spring)
3-0-9
Preparation and analysis of financial statements. Focuses on measuring and reporting of corporate performance for investment decisions, stock valuation, bankers’ loan risk assessment, and evaluations of employee performance, for example. Emphasizes the necessarily interdisciplinary understanding of business. Concepts from finance and economics (e.g., cash flow discounting, risk, valuation, and criteria for choosing among alternative investments)
place accounting in the context of the business enterprise.  
*J. Weber, S. Keating*

**15.511 Financial Accounting**  
Prereq: Permission of instructor  
G (Summer)  
3-0-6 H-LEVEL Grad Credit  
Introduces concepts of corporate financial accounting and reporting of information widely used in making investment decisions, corporate and managerial performance assessment, and valuation of firms. Students perform economics-based analysis of accounting information from the viewpoint of the user (especially senior managers) rather than the preparer (the accountant). Restricted to Sloan master’s students.  
*R. Watts*

**15.514 Financial and Managerial Accounting**  
Prereq: None  
G (Summer)  
3-0-9  
An intensive introduction to the preparation and interpretation of financial information for investors (external users) and managers (internal users) and to the use of financial instruments to support system and project creation. Adopts a decision maker perspective on accounting and finance. Restricted to System Design and Management students.  
*S. Keating*

**15.515 Financial Accounting**  
Prereq: Permission of instructor  
G (Fall)  
4-0-5 H-LEVEL Grad Credit  
An intensive introduction to the preparation and interpretation of financial information. Adopts a decision-maker perspective of accounting by emphasizing the relation between accounting data and the underlying economic events generating them. Class sessions are a mixture of lecture and case discussion. Assignments include textbook problems, analysis of financial statements, and cases. Restricted to first-year Sloan master’s students.  
*J. Weber*

**15.516 Corporate Financial Accounting**  
(Subject meets with 15.501)  
Prereq: Permission of instructor  
G (Fall, Spring)  
3-0-9 H-LEVEL Grad Credit (except for Course 15 students)  
See description under subject 15.501. If subject is oversubscribed, priority is given to Course 15 students.  
*R. Watts*

**15.518 Taxes and Business Strategy**  
Prereq: 15.501, 15.511, 15.515, or 15.516  
G (Fall, Spring)  
3-0-6 H-LEVEL Grad Credit  
Provides a conceptual framework for thinking about taxes. Applications covered include mergers and acquisitions, tax arbitrage strategies, business entity choice, executive compensation, multi-national tax planning, and others. Aimed at investment bankers and consultants who need to understand how taxes affect the structure of deals; managers and analysts who need to understand how firms strategically respond to taxes; and entrepreneurs who want to structure their finances in a tax-advantaged manner.  
*S. P. Kothari*

**15.521 Management Accounting and Control**  
Prereq: 15.501, 15.511, 15.515, or 15.516  
G (Spring)  
3-0-6 H-LEVEL Grad Credit  
Examines management accounting and related analytical methodologies for decision making and control in organizations. Product costing, budgetary control systems, and performance evaluation systems for planning, coordinating, and monitoring the performance of a business. Defines principles of measurement and develops framework for assessing behavioral dimensions of control systems; impact of different managerial styles on motivation and performance in an organization.  
*S. Keating*

**15.522 Security Design and Corporate Financing**  
Prereq: 15.401; 15.402 or 15.414; 15.433 or 15.434  
G (Spring)  
3-0-6 H-LEVEL Grad Credit  
Examines how corporations choose securities and markets to finance themselves. These are decisions which the firm must make after it has determined its financial policies including capital structure and dividend policy. Subject discusses recent trends in corporate financing including globalization, secularization, and transformation. Explores new securities and institutional factors, particularly tax and accounting factors that affect their design.  
*P. Asquith*

**15.535 Business Analysis Using Financial Statements**  
Prereq: 15.501, 15.511, 15.515, or 15.516; 15.411, 15.414 or 15.401  
G (Fall, Spring)  
3-0-6 H-LEVEL Grad Credit  
Presents a framework for business analysis and provides students with tools for financial statement analysis, including strategic, accounting, financial, and prospective analysis. Concepts are then applied to a number of decision making contexts, such as credit analysis, company performance assessment, merger analysis, financial policy decisions, and securities analysis.  
*J. Ng, E. Sletten*

**15.539 Doctoral Seminar in Accounting**  
Prereq: 15.515  
G (Fall, Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit  
Designed primarily for doctoral students in accounting and related fields. The reading list consists of accounting research papers. Objective is to introduce research topics, methodologies, and developments in accounting, and train students to do independent research.  
*J. Weber*

**15.545 Mergers and Acquisitions: The Market for Corporate Control**  
Prereq: 15.401, 15.411, or 15.414; 15.402; 15.511, 15.515, or 15.516  
G (Fall, Spring)  
2-0-4 H-LEVEL Grad Credit  
Probably the most dramatic events in a corporation’s history involve the decision to acquire another firm or the decision to oppose being acquired. This is also one of the areas of management most thoroughly documented in the financial press and the academic literature. Subject explores three aspects of the merger and acquisition process: the strategic decision to acquire, the valuation decision of how much to pay, and the financing decision on how to fund the acquisition. Class sessions alternate between discussions of academic readings and applied cases.  
*Staff*
15.561 Information Technology Essentials
Prereq: None
G (Spring)
3-0-6
Examines technology concepts and trends underlying current and future uses of information technology (IT) in business. Emphasis on networks and distributed computing, including the web. Other topics include hardware and operating systems, software development tools and processes, relational databases, security and cryptography, enterprise applications, and electronic commerce. Exposure to web, database, and graphical user interface (GUI) tools. Primarily for Sloan master’s students with limited IT background.
T. W. Malone

15.564 IT Essentials II: Advanced Technologies for Digital Business in the Knowledge Economy
Prereq: None
G (Spring)
3-0-6
Technologies and concepts for next generation knowledge management and web e-business, including semantic web and web services. Business applications for use in the next two to seven years, including: e-commerce, marketing, finance, trust/security, health/biomedical, mobile. Strategic impacts and entrepreneurial opportunities. Core skills for identifying and evaluating technologies and their business potential, and for managing innovative IT-dependent projects. Overall emphasis on business process automation and e-services.
S. Madnick

15.565J Evolution Towards Web 3.0 and the Emergence of Management 3.0
(Same subject as ESD.565J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.578
Examines the evolution from Web 2.0, with its emphasis on interactivity through online collaboration and sharing among users (primarily through social networking sites, wikis and communication tools), to Web 3.0, which focuses on high proactivity, transforming the Web into a database, and the leveraging of artificial intelligence technologies, such as the Semantic Web. Introduces Management 3.0 and the range of new Web technologies, applications, and business opportunities and challenges that it supports. Includes case studies, industry and academic speakers, discussion of basic principles, and a team project.
S. Madnick

15.567 The Economics of Information: Strategy, Structure and Pricing
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Analysis of the underlying economics of information with management implications. Topics include industry structure, incentives, and business organization. Pricing, bundling and versioning of digital goods including music, video, software and communication services. Managerial uses of intellectual property, innovation incentives, search, targeted advertising, personalization, privacy, network externalities, open source and alliances. Discussion of principles, cases, industry speakers and a team project.
E. Brynjolfsson

15.568 Management of Information Systems
Prereq: 1.00 or 6.001
U (Spring)
3-0-6
Covers how the business value of individuals, as well as of organizational investments and innovation, is maximized in IT. Topics include IT-specific project-management, outsourcing, business-process design, alignment with organizational goals, operational efficiencies, change management, business transformation, agility, and associated strategy. Complements knowledge of programming or technology with organizational and people aspects. Emphasizes effective pragmatic decision-making. Presents and uses analytical frameworks, concepts, guidelines, cases, field research, and extensive discussion. Restricted to undergraduates.
S. Madnick

15.569 Leadership Lab: Leading Sustainable Systems
Prereq: Permission of instructor
G (Fall, IAP)
6-0-6 H-LEVEL Grad Credit
One of the key leadership challenges in contemporary organizations is creating systems of management that are commensurate with the scope and complexity of issues faced by business. Examines mental models and practices that keep people and organizations stuck in unproductive system dynamics. Explores alternative ways to view and organize systems that pay attention to cross-boundary interdependencies, while enabling the alignment of core business concerns with key social and environmental issues. Re-
15.576 Research Seminar in Information Technology and Organizations: Social Perspectives
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Examines the assumptions, concepts, theories, and methodologies that inform research into the social aspects of information technology. Extensive reading and discussion of research literature aimed at exploring micro, group, and macro level social phenomena surrounding the development, implementation, use and implications of information technology in organizations. Primarily for doctoral students.
W. J. Orlikowski

15.578 Global Information Systems: Strategic, Technical, and Organizational Perspectives
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.565
S. E. Madnick

15.579–15.580 Special Seminar in Information Technology
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Group study of current topics related to information technology not otherwise included in curriculum.
S. E. Madnick, T. W. Malone, W. Orlikowski

15.599 Workshop in Information Technology
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit
Presentations by faculty, doctoral students, and guest speakers of ongoing research relating to current issues in IT, as well as discussions of key research papers in the field. Specific topics determined by the interest of participants and by new and important directions in Information Technology. Background readings and active participation by students expected. Primarily for doctoral students.
E. Brynjolfsson, W. Orlikowski

LAW

15.615 Basic Business Law for the Entrepreneur and Manager
Prereq: None
G (Fall, Spring)
3-0-6
One of three alternative courses (15.615, 15.616, and 15.617) each designed to provide managers with the solid foundation in business law needed to exercise judgment and leadership when confronting a broad range of complex law-sensitive issues. Includes most topics covered in 15.615, some at a quicker pace. Extra attention to mergers and acquisitions, capital markets and private equity, the regulation of financial service providers, and legal risks associated with innovative financial products and services. May appeal to students interested in finance.
J. Akula

15.616 Basic Business Law, Tilted Towards Innovation and Strategy
Prereq: None
G (Fall)
3-0-6
One of three alternative courses (15.615, 15.616, and 15.617) each designed to provide managers with the solid foundation in business law needed to exercise judgment and leadership when confronting a broad range of complex law-sensitive issues. Includes most topics covered in 15.615, some at a quicker pace. Extra attention to the legal frameworks of transnational business, cutting-edge technologies and products, and restructuring and repositioning major corporations. May appeal to students interested in strategic management and consulting.
J. Akula

15.617 Basic Business Law, Tilted Towards Finance
Prereq: None
G (Spring)
3-0-6
One of three alternative courses (15.615, 15.616, and 15.617) each designed to provide managers with the solid foundation in business law needed to exercise judgment and leadership when confronting a broad range of complex law-sensitive issues. Includes most topics covered in 15.615, some at a quicker pace. Extra attention to mergers and acquisitions, capital markets and private equity, the regulation of financial service providers, and legal risks associated with innovative financial products and services. May appeal to students interested in finance.
J. Akula

15.628 Patents, Copyrights, and the Law of Intellectual Property
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
2-0-4 [P/D/F] H-LEVEL Grad Credit
Introductory examination of the US law of intellectual property, with emphasis on patents and copyrights, and a brief look at trademarks and trade secrets. Comparisons made with regard to what can and cannot be protected, what rights the owner does and does not obtain, and how these rights come into being. Issues relating particularly to new information technologies highlighted. Assignments include case and statutory readings, written preparatory exercises, and student case presentations. Regular attendance required. No listeners.
J. A. Meldman

15.647–15.649 Special Seminar in Law
Prereq: None
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Group study of current topics related to law not otherwise included in curriculum.
J. L. Akula

15.655J Law, Technology, and Public Policy
(Same subject as ESD.132J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.132J.
N. A. Ashford, C. C. Caldart
15.657j Sustainability, Trade, and the Environment
(Same subject as 1.813j, 11.466j, ESD.137j)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.137j.
N. A. Ashford

15.658j Real Estate Development III: Legal Issues in the Development Process
(Same subject as 11.340j)
Prereq: Permission of instructor
G (Spring; second half of term)
3-0-3 H-LEVEL Grad Credit
See description under subject 11.340j.
L. Fisher, J. Pennington

INDUSTRIAL RELATIONS AND HUMAN RESOURCE MANAGEMENT

15.660 Strategic Human Resource Management
Prereq: 15.311
G (Spring)
3-0-6 H-LEVEL Grad Credit
Design and execution of human resource management strategies. Two central themes: How to think systematically and strategically about aspects of managing the organization’s human assets, and what really needs to be done to implement these policies and to achieve competitive advantage. Adopts the perspective of a general manager and addresses human resource topics (including reward systems, performance management, high-performance human resource systems, training and development, recruitment, retention, equal employment opportunity laws, work-force diversity, and union-management relationships) from a strategic perspective. E. Castilla

15.664 Careers, Leadership, and Negotiations in the New Economy
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
4-0-8
Discusses how work, careers, and organizations are changing and the leadership skills required of professionals in contemporary organizations and society. Topics include the changing nature of work and careers, the role of knowledge in organizations and the economy, work-family integration, negotiations and conflict management, teamwork, leadership, and the management of diversity. Classes involve simulations, cases and negotiation exercises. Students develop a personal leadership and career development plan and work in teams to conduct an action-research project on campus related to one of the subject’s topics. P. Osterman, T. Kochan

15.665 Power and Negotiation
Prereq: Permission of instructor
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Provides understanding of the theory and processes of negotiation as practiced in a variety of settings. Designed for relevance to the broad spectrum of bargaining problems faced by the manager and professional. Allows students an opportunity to develop negotiation skills experimentally and to understand negotiation in useful analytical frameworks. Emphasizes simulations, exercises, role playing, and cases. Undergraduates may register for this subject provided they are ready to participate with the intensity expected for a grad H-level subject J. Curhan, L. Baccar

15.667 Negotiation and Conflict Management
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Presents negotiation theory—strategies and styles—within an employment context. Special emphasis on sources of power in negotiation. Covers conflict management as a first party and as a third party (third-party skills include helping others deal directly with their conflicts, mediation, investigation, arbitration, and helping the system itself to change as a result of a dispute). Special cases include abrasiveness, dangerousness, racism, sexism, whistleblowing, and ethics. Simulations of difficult situations such as cross-cultural mentoring and an emergency. One double class. Requires a commitment to attend all classes. Undergraduates may register for this subject provided they are ready to participate with the intensity expected for a grad H-level subject. M. P. Rowe, T. Kochan

15.668 People and Organizations
Prereq: None
U (Fall)
3-0-6
Examines the historical evolution and current human and organizational contexts in which scientists, engineers and other professionals work. Outlines today’s major challenges facing the management profession. Uses interactive exercises, simulations and problems to develop critical skills in negotiations, teamwork, and leadership. Introduces concepts and tools to analyze work and leadership experiences in optional undergraduate fieldwork projects. Preference to Management minors and other undergraduates not majoring in Management Science. T. Kochan, J. Carroll, P. Osterman

15.670 Leadership and Change
Prereq: 15.668, permission of instructor
U (Fall; first half of term)
2-0-4
Applies concepts introduced in 15.668. Explores leadership and organizational change learned as a result of fieldwork experience. Alternative styles of leadership analyzed. Development of personal leadership plans. Approved fieldwork experience required for admission. Staff

15.676 Work, Employment, and Industrial Relations Theory
Prereq: Permission of instructor
G (Spring)
2-0-7 H-LEVEL Grad Credit
Can be repeated for credit
Historical evolution and assessment of different theories and disciplinary perspectives used in research on work, employment, and industrial relations. Introduces doctoral students to the field and explores where their research interests fit within the broader field. First part compares the normative assumptions, theories, and methodologies used by economists, historians, sociologists, psychologists, political scientists, and legal scholars from the latter 19th century to the present. Final portion explores strategies for advancing research on topics of current interest to participants. T. Kochan, D. Burton, R. M. Locke, P. Osterman

15.677 Urban Labor Markets and Employment Policy
(Same subject as 11.427j)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Discusses the broader trends in the labor market, how urban labor markets function, public and private training policy, other labor market programs, the link between labor market policy and economic development, and the organization of work within firms. P. Osterman
15.678J Political Economy I: Theories of the State and the Economy
(Same subject as 14.781J, 17.100J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 17.100J.
M. Piore, S. Berger

15.691 Research Seminar in Work, Employment and Industrial Relations
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Discusses important areas for research in work, employment and industrial relations; frameworks for research, research techniques, and methodological problems. Centered mainly on staff research and the thesis research of advanced graduate students and invited guests.
Consult T. A. Kochan

15.698 Special Seminar in Industrial Relations and Human Resource Management
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Group study of current topics related to industrial relations and human resource management not otherwise included in curriculum.
Consult P. Osterman

OPERATIONS MANAGEMENT

15.760 Introduction to Operations Management
Prereq: 15.060 or 6.041
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
2-0-4 H-LEVEL Grad Credit
Introduction to problems and analysis related to the design, planning, control and improvement of manufacturing and service operations. Includes process analysis, project analysis, materials management, production planning and scheduling, quality management, supply chain design and coordination, reengineering, design for manufacturing, capacity and facilities planning, and operations strategy.
J. Gallien, R. Levi

15.761 Introduction to Operations Management
Prereq: 15.060, 6.041, or permission of instructor
G (Spring, Summer)
4-0-5 H-LEVEL Grad Credit
In-depth introduction to the fundamental concepts and techniques related to the design, planning, control, and improvement of manufacturing and service operations. Covers a broad range of applications and industries such as high-tech, financial services, insurance, automotive, healthcare, and retail. Special emphasis on the effects of uncertainty in operational decision making and to the interplay between high-level financial objectives and low-level operational guidelines. Topics include process description, flow diagrams, capacity analysis, capacity ROI, cycle time analysis, inventory management, delayed postponement, production control, risk pooling, quality management, process design and revenue management. Summer section is primarily for LGO students.
D. Rosenfield, J. Gallien, R. Levi, V. F. Farias

15.762J Supply Chain Planning
(Same subject as 1.273J, ESD.267J)
Prereq: 1.260J, 1.760, or 1.761
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
Focuses on effective supply chain strategies for companies that operate globally, with emphasis on how to plan and integrate supply chain components into a coordinated system. Students are exposed to concepts and models important in supply chain planning with emphasis on key tradeoffs and phenomena. Introduces and utilizes key tactics such as risk pooling and inventory placement, integrated planning and collaboration, and information sharing. Lectures, computer exercises, and case discussions introduce various models and methods for supply chain analysis and optimization. Recommended for Operations Management concentrators.
S. C. Graves, D. Simchi-Levi

15.763J Manufacturing System and Supply Chain Design
(Same subject as 1.274J, ESD.268J)
Prereq: 1.260J, 1.760, or 1.761
G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit
Focuses on decision making for system design, as it arises in manufacturing systems and supply chains. Students exposed to frameworks and models for structuring the key issues and tradeoffs. Presents and discusses new opportunities, issues and concepts introduced by the internet and e-commerce. Introduces various models, methods and software tools for logistics network design, capacity planning and flexibility, make buy, and integration with product development. Industry applications and cases illustrate concepts and challenges. Recommended for Operations Management concentrators.
S. C. Graves, D. Simchi-Levi

15.764J the Theory of Operations Management
Prereq: 15.081J or 6.251J, 6.436J; or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Focus on theoretical work for studying operations planning and control problems. Topics vary from year to year, and include supply chain design and coordination, logistic and distribution systems, make-to-order systems, call centers and service operations, procurement, pricing, revenue management, the sales/production interface, inventory theory, flexible manufacturing systems.
V. Farias

15.765J International Supply Chain Management
(Same subject as 1.265J, 2.965J, ESD.265J)
Prereq: 1.260J, 1.261J, 1.262J, 1.760, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010-2011: G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
See description under subject 2.965J.
Staff

15.766 Management of Services: Concepts, Design, and Delivery
Prereq: 15.760, 15.761, or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.778
Explores the use of operations tools and perspectives in the service sector, including both for-profit and not-for-profit organizations. Builds on conceptual frameworks and cases from a wide range of service operations, selected from health care, hospitality, internet services, supply chain, transportation, retailing, food service, entertainment, financial services, humanitarian services, government services, and others.
C. Fine
15.769 Operations Strategy
Prereq: 15.760, 15.761, or permission of instructor
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Provides unifying framework for analyzing strategic issues in manufacturing and service operations. Analyzes relationships between manufacturing and service companies and their suppliers, customers, and competitors. Also covers decisions in technology, facilities, vertical integration, human resources and other strategic areas. Explores means of competition such as cost, quality, and innovativeness. Provides an approach to make operations decisions in the era of outsourcing and globalization.
Fall: C. H. Fine
Spring: D. B. Rosenfield

15.770J Logistics Systems
(Same subject as 1.260J, ESD.260J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to supply chain management from both analytical and practical perspectives. Stressing a unified approach, the course allows the student to develop a framework for making intelligent decisions within the supply chain. Key logistics functions are covered to include demand planning, procurement, inventory theory and control, transportation planning and execution, reverse logistics, and flexible contracting. Concepts explored include postponement, portfolio management, dual sourcing, and others. Emphasis is placed on being able to recognize and manage risk, analyze various tradeoffs, and model logistics systems.
Y. Sheffi, C. Caplice

15.771J Case Studies in Logistics and Supply Chain Management
(Same subject as 1.261J, ESD.261J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
A combination of lectures and cases covering the strategic, management, and operating issues in contemporary logistics and integrated supply chain management. Includes: logistics strategy; supply chain restructuring and change management; and distribution, customer service, and inventory policy.
J. Byrnes

15.778 Management of Supply Networks for Products and Services
Prereq: None
G (Summer)
3-0-6 Credit cannot also be received for 15.768
Integrated approach to the analysis, design and management of supply networks for products and services. Based on the study and discussion of concepts, examples, and case studies from a wide range of industries, the emphasis is on developing the following two critical themes:
(1) a basic structure or foundation for analyzing, designing and operating supply chains (SCs) that relies on both fundamental concepts such as the management of SC inventory, planning of SC operations and logistics; as well as a discussion therein of the value of (timely) information, and of the need for collaboration and coordination between the SC players,
(2) conceptual frameworks that focus on the emergence of a wide range of enabling services in SCs which in turn are proving to be critical success factors for the survival and growth of this class of systems; as part of these frameworks we will also discuss ideas and models for managing service operations. Guest speakers will present personal experiences on various aspects of the service industry and supply chains. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.
Consult G. Bitran

15.783J Product Design and Development
(Same subject as 2.739J, ESD.32J)
Prereq: 2.009, 15.760, 15.761, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Covers modern tools and methods for product design and development. The cornerstone is a project in which teams of management, engineering, and industrial design students conceive, design, and prototype a physical product. Class sessions employ cases and hands-on exercises to reinforce the key ideas. Topics include product planning, identifying customer needs, concept generation, product architecture, industrial design, concept design, robust design, and green design practice.
S. Eppinger, W. P. Seering

15.792J Proseminar in Manufacturing
(Same subject as 2.890J, 3.80J, 10.792J, 16.98S)
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Provides an integrative forum for operations and manufacturing students. Projects focus on leadership, service, and improvement. Covers a set of integrative operations and manufacturing topics or issues such as leadership, implementation of lean operations, or other improvements. Presents examples of both operations excellence and challenges. Includes presentations by guest speakers such as senior-level managers of manufacturing companies. Students play a large role in managing the course. Preference to LGO students.
D. B. Rosenfield

15.794 Research Project in Manufacturing
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
A special projects subject designed for Leaders for Global Operations (LGO) students in conjunction with on-site projects at LGO partner companies. Student teams work on faculty-supervised thesis research projects that deal with a specific aspect of manufacturing. Students required to summarize their work in the context of understanding organization, leadership, teamwork, and task management in conjunction with 15.317.
D. B. Rosenfield

15.795 Seminar in Operations Management
Prereq: 15.760 or 15.761
G (Spring)
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year. Typical examples from past years: manufacturing strategy, technology supply chains.
C. H. Fine

15.799 Workshop in Operations Management
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit
Presentations by faculty, doctoral students, and guest speakers of ongoing research relating to current issues in operations management, including reports of research projects (proposed or in progress) and informal discussions of
recent literature dealing with subjects of special interest to participants. Primarily for doctoral students. 

**Staff**

**MARKETING**

**15.809 Marketing Management**
Prereq: None  
G (Summer)  
3-0-6  
Marketing is a rigorous, disciplined science that applies a reasoned framework to the selection of target markets and the optimization of marketing decisions. The subject has two parts: a tactical portion and a strategic portion. The strategic portion focuses on identifying target markets. The tactical portion reviews how firms optimize profits in their chosen markets. Tactical topics include pricing, promotion, channel and product issues. Restricted to MIT Sloan Fellows in Innovation and Global Leadership. 

*J. Simester*

**15.810 Marketing Management**
Prereq: None  
G (Fall, Spring)  
3-0-6  
Analyzes marketing problems through the lens of an analytical framework. Subject has both tactical and strategic portions. Tactical portion reviews methods firms use to optimize profits in markets they choose to target. Topics include pricing, promotion, distribution and product issues as well as how to gather customer input and differentiate yourself from competitors. Strategic portion focuses on identifying marketing competencies and using these competencies to identify target markets and set marketing strategy. Explores theory and practice using lectures, cases, discussions, and readings. 

*J. R. Hauser, M. Braun*

**15.812 Marketing Management**
Prereq: None  
U (Spring)  
3-0-6  
Provides a comprehensive introduction to contemporary marketing concepts and techniques, such as customer analysis, market segmentation, targeting, positioning, branding, product design, pricing, promotion, and distribution. Taught using lectures, case studies, and class demonstrations. Not open to Sloan graduate students. 

*J. Zhang*

**15.818 Pricing**
Prereq: None  
G (Spring)  
3-0-6  
Framework for understanding pricing strategies and tactics. Topics covered include price customization, pricing complementary products, anticipating competitive price responses, pricing in platform markets, pricing in business to business markets, and pricing of new products. Lectures and cases. 

*C. Tucker*

**15.821 Listening to the Customer**
Prereq: None  
G (Fall)  
3-0-3  
Introduction to soft consumer research methods, useful for getting quick customer input into decisions on product design and development, strategic positioning, advertising, and branding. Covers interview techniques, observational methods, voice of the customer, focus groups, and analyses suitable for qualitative data. Introduces new information-gathering methods in development at MIT. 

*J. Tucker*

**15.822 Strategic Market Measurement**
Prereq: None  
G (Fall)  
3-0-3  
Project subject teaches students how to create, carry out, interpret, and analyze a market research questionnaire. Emphasis on discovering market structure and segmentation, but students can pursue other project applications. Includes a user-oriented treatment of multivariate analysis (factor analysis, multidimensional scaling, conjoint and cluster analysis). 

*D. Prelec*

**15.828 Design and Marketing New Products**
Prereq: 15.809, 15.810 or 15.812  
G (Spring; first half of term)  
3-1-5 H-LEVEL Grad Credit  
Practical introduction to the process of designing and marketing new products. Covers the major phases of product development: opportunity identification (customer input, generating ideas, market definition), product design and positioning, pre-market testing and forecasting, launch marketing, and managing the life cycle. Presents proven techniques, but emphasizes state of the art methods like “listening in,” virtual customer, information acceleration, and trust-based marketing. Group project allows students to apply lessons to the design and marketing of a real product—the hydrogen fuel auto. 

*G. L. Urban*

**15.833 Business-to-Business Marketing**
Prereq: 15.809, 15.810, or 15.812  
G (Fall; second half of term)  
3-0-3 H-LEVEL Grad Credit  
Applies marketing concepts, analyses and tools used in business-to-business (B2B) marketing which accounts for more than half of the economic activity in the US. Develops an understanding of customer value management as a strategy for delivering superior value to targeted business segments while maintaining equitable returns. Using an analytical framework, students assess components of customer value and translate them into actionable marketing strategies and programs. Focuses on brand building, web and technology facilitation of the supply chain, and customer relationship management. Underscores sales force management within the context of go-to-market strategy. Discusses ethical issues and various B2B contexts such as products and services, for-profits and non-profits, domestic and global markets. Emphasis on applications in technology and healthcare domains. Includes case studies, applied exercises, and readings. 

*S. Chatterjee*

**15.834 Marketing Strategy**
Prereq: None  
G (Spring)  
3-0-6  
Introduces tools from strategy and economics to look systematically at marketing strategy. Topics include how to maximize value for the customer-firm-supplier triad and how to develop new sources of competitive advantage. Taught mostly with cases. Half-term subject. 

*B. Wernerfelt*

**15.836 New Product and Venture Development Proseminar**
Prereq: None  
Acad Year 2009-2010: G (Fall)  
Acad Year 2010-2011: Not offered  
3-0-3 H-LEVEL Grad Credit  
Provides an overview and feel for what is involved in new product development within a larger organization, as well as in start-up firms. The key question is: How does an idea or an invention become a successful innovation in the marketplace? Seminar features a series of speakers who focus on specific aspects of this process, from topics such as “the fuzzy front end” that seed teams face, championing an idea through an organization, keeping an entrepreneurial
spirit alive, growing pains, designing the business plan, meeting communications challenges, and using creative marketing techniques. D. Prelec

15.838 Research Seminar in Marketing
Prereq: 15.810
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit
Seminar on current marketing literature and current research interests of faculty and students. Topics such as marketing models, consumer behavior, competitive strategy, marketing experimentation, and game theory. Restricted to doctoral students. Consult D. Prelec

15.839 Workshop in Marketing
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Presentations by faculty, doctoral students, and guest speakers of ongoing research relating to current issues in marketing. Topics: reports of research projects (proposed or in progress) and informal discussions of recent literature dealing with subjects of special interest to participants. Restricted to doctoral students. Staff

15.840–15.843 Special Seminar in Marketing
Prereq: 15.809, 15.810, or 15.812
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Group study of current topics related to marketing not otherwise included in curriculum. Staff

15.846 Branding
Prereq: 15.809, 15.810 or 15.812
G (Spring; second half of term)
3-0-6 H-LEVEL Grad Credit
Covers elemental decisions about message design given different managerial objectives. Investigates the role of advertising in one particularly important objective, brand-building. Discussion of current marketing research focuses on the importance of consumer perception in advertising/branding efficacy and integrated marketing communications as an emerging goal in advertising efforts. Topics include smoky signals, sticky brands, and the medium/content interaction. Explores theory and practice through lectures, discussions, and readings. R. Richardson

15.847 Consumer Behavior
Prereq: 15.809, 15.810 or 15.812
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit
Presents research from cognitive and social psychology, decision theory, and behavioral economics to help us understand why consumers buy (or not) and the processes they use to evaluate products and choose between them. Topics include “framing,” heuristics and biases of judgment and choice, attitudes and attitude change, information processing, influence, the role of the group, and social marketing. Emphasizes how experimental results (what we conclude about consumers from studies) and real-world outcomes (what consumers actually do) are surprisingly sensitive to subtle procedural or contextual details. J. Ackerman

15.848 Marketing Models
Prereq: 15.810, 15.060
G (Spring)
3-0-3
Quantitative models and methods in marketing such as choice models, positioning analyses, market response, inter-firm competition. Coverage includes the marketing phenomena under consideration, underlying modeling assumptions and their realism, the main implications of the model, and the insights gained. Undergraduates should have completed 15.812 and 6.041. Half term subject. Consult J. Little

15.872 System Dynamics II
Prereq: 15.871
G (Fall, Spring; second half of term)
3-0-3 H-LEVEL Grad Credit
Continuation of 15.871, emphasizing tools and methods needed to apply systems thinking and simulation modeling successfully in complex real-world settings. Uses simulation models, management flight simulators, and case studies to deepen the conceptual and modeling skills introduced in 15.871. Through models and case studies of successful applications students learn how to use qualitative and quantitative data to formulate and test models, and how to work effectively with senior executives to implement change successfully. Prerequisite for further work in the field. J. D. Sterman, N. P. Repenning

15.875 Applications of System Dynamics
Prereq: 15.874
G (Spring)
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit
Explores how organizations can use system dynamics to achieve important goals. Student teams work with client managers to tackle the clients’ most pressing issues. Students discuss experiences with their clients, and learn modeling and consulting skills they need to be effective. Focus on gaining practical insight from the system dynamics process. Projects are sponsored by diverse organizations from a range of industries and sizes from start-ups to the Fortune 500. Consult J. Sterman

15.877 Research Seminar in System Dynamics
Prereq: 15.874 and permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Doctoral level seminar in system dynamics modeling, with a focus on social, economic and technical systems. Covers classic works in dynamic modeling from various disciplines and current research problems and papers. Participants critique the theories and models, often including replication, testing, and improvement of various models, and lead class discussion. Topics vary from year to year. Consult J. D. Sterman, N. P. Repenning

SYSTEM DYNAMICS

15.871 Introduction to System Dynamics
Prereq: Permission of instructor
G (Fall, Spring)
3-0-3 H-LEVEL Grad Credit
Introduction to systems thinking and system dynamics modeling applied to strategy, organizational change, and policy design. Students use simulation models, management flight simulators, and case studies to develop conceptual and modeling skills for the design and management of high-performance organizations in a dynamic world. Case studies of successful applications of system dynamics in growth strategy, management of technology, operations, supply chains, product development, and others. Principles for effective use of modeling in the real world. J. D. Sterman, N. P. Repenning
15.900 Strategic Management
Prereq: None
G (Spring)
3-0-6
Explores a wide range of strategic problems, focusing particularly on the sources of competitive advantage and the interaction between industry structure and organizational capabilities. Introduces a wide variety of modern strategy frameworks and methodologies. Builds upon and integrates material from core topics such as economics, organizational processes, and marketing.
E. Zuckerman

15.902 Strategic Management
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Focuses on some of the important current issues in strategic management. Concentrate on modern analytical approaches and enduring successful strategic practices. Designed with a technological and global outlook since this orientation in many ways highlights the significant emerging trends in strategic management. Provides students with a pragmatic approach that guides the formulation and implementation of corporate, business, and functional strategies. Half-term subject. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.
A. Hax

15.903 Corporate Strategy and Extended Enterprises
Prereq: 15.900, 15.010, 15.311
G (Spring; first half of term)
3-0-3 H-LEVEL Grad Credit
Focuses on how managers build and manage complex organizations to achieve strategic goals. Develops theoretical frameworks that build on 15.010, 15.311, and 15.900. Applies these frameworks to corporate strategy (i.e., the design and management of the multi-business firm) and extended enterprises (i.e., the design and management of multi-firm structures such as supply chains, alliances, joint ventures, and networks).
R. Gibbons

15.904 Advanced Strategic Management
Prereq: 15.900 or 15.902
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit
Builds on the core strategic management courses 15.900 and 15.902 to explore the roots of sustained competitive advantage. Using a mix of case studies, models and readings, explores the interaction between “structural” and “organizational” sources of long-lasting excellence, focusing on those sources of performance that are particularly difficult for competitors to imitate. Student groups focus on a single high-performing firm as a means to sharpen and apply the tools, methods, and concepts introduced in the course. Emphasis throughout on the implications of the material for the choices that managers must make in formulating strategy and running a business.
Staff

15.905 Technology Strategy for SDM
Prereq: None
G (Spring)
3-0-9
Provides a series of strategic frameworks for managing high-technology businesses. Emphasis on the development and application of conceptual models which clarify the interactions between competition, patterns of technological and market change, and the structure and development of internal firm capabilities. SDM students only, except with instructor permission.
M. Davies

15.912 Technology Strategy
Prereq: 15.900 or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Outlines tools for formulating and evaluating technology strategy, including the interactions between competition, patterns of technological and market change, and the structure and development of organizational capabilities. Topics include making money from innovation, competition between technologies and the selection of standards, managing joint ventures and collaborative innovation, organization of R&D and technology platforms, and theories of diffusion and adoption. Readings and case studies on firms such as Apple, Google, Toyota Prius, Novartis, and Linux illustrate central concepts.
J. P. Davis

15.913 Strategies for Sustainable Business (New)
Prereq: None
G (Spring; first half of term)
3-0-3
Develops a pragmatic, action-oriented approach to organizational sustainability. Discusses how sustainability is changing existing business models and market structures, how to develop sustainable management practices, and how firms can implement those practices successfully. In-class simulations, cases, role-playing, and guest speakers explore emerging strategies for sustainable businesses and organizations.
R. Locke, S. Slaughter, J. Sterman

15.914 Competitive Dynamics and Strategy—Winning in Technology Markets
Prereq: 15.871 or 15.874; 15.365, 15.350, 15.351, 15.900, 15.902 or 15.912
G (Spring)
2-0-7 H-LEVEL Grad Credit
Focuses on competitive strategy in technology-driven markets. Explores the signature dynamics common to almost all such markets: innovation, technology substitution, product lifecycles, commoditization, disruption, transformation of mature businesses, and technology ecosystems. Over the term students acquire a portfolio of models of the signature dynamics. They use the models in projects with participating companies to analyze technology markets, formulate competitive strategies, and illuminate the challenges of execution. Issues addressed are critical for both established incumbents and new market entrants. It is a “master class” in applied corporate strategy. Restricted to graduate students.
H. B. Weil

15.915 Laboratory for Sustainable Business
Prereq: 15.913
G (Spring; second half of term)
3-0-3 H-LEVEL Grad Credit
Focuses on what companies can do to address the challenges we face as a society and as a species. Explores how commercial firms—and the organizations that seek to work with them—respond to problems including climate change, environmental degradation, and social dislocation. Provides instruction for crafting practical and effective policies committed to both the reality of “the bottom line” and the need to sustain the natural and human systems on which we all rely. Students work in teams with a company/organization on a real-world sustainability project throughout the term.
R. Locke, S. Slaughter, J. Sterman
MANAGEMENT

15.933 Strategic Opportunities in Energy
Prereq: 15.900 or permission of instructor
G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
Provides frameworks for understanding the structure and dynamics of the energy sector and the strategic opportunities available within it. Opportunities (in sources, uses, and interfaces) resulting from emerging technologies, market dynamics, and changing policies are analyzed using these frameworks, and are addressed from the perspectives of established energy companies, technology developers, equipment and service suppliers, financial players, and entrepreneurs.
D. Lessard, H. Weil

15.941J Leadership in the Real Estate Industry
(Same subject as 11.430J)
Prereq: None
G (Fall)
3-0-6
Provides and uses theories, concepts and tools to craft, articulate and refine a leadership point of view. Through reflection, self-assessment, discussion and feedback, develops an understanding of the readiness to lead, leadership style, emotional intelligence, and presentation of self. Students converse with leaders in the real estate industry and gain knowledge from their stories and insights. Aims to provide students with a deeper understanding of leadership; a better understanding of themselves and their authentic leadership style; and a plan for the ongoing development of their leadership capabilities.
G. Schuck

15.943 Explaining Heterogeneity in Firm Performance
Prereq: Permission of instructor; or Coreq: 14.121, 14.122, 14.271, or 14.382
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-3 H-LEVEL Grad Credit
Focuses attention on the sources of heterogeneity in firm performance. Most research in economics, particularly in industrial organization theory, assumes that firms are homogeneous in terms of knowledge, production structure, and factor price environment. Research in the tradition of strategic management, in contrast, focuses attention on heterogeneity across firms as the primary driver of the nature of competition and of the sources of firm performance. Introduces doctoral students in strategic management and economics to the evidence for persistent heterogeneity. Restricted to doctoral students.
P. Azoulay

15.944 The Economic and Strategic Analysis of Technology Intensive Industries
Prereq: Permission of instructor; or Coreq: 14.121, 14.122, 14.271, or 14.382
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-3 H-LEVEL Grad Credit
This doctoral course explores the extensive literature in the economics of innovation and technological change. Restricted to doctoral students.
P. Azoulay, R. Henderson, E. Berndt

SPECIAL STUDIES

15.950 Special Studies in Management
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
15.951 Special Studies in Management
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Special tutorial arrangement with a faculty member for guided reading, research, laboratory, or teaching experience.
J. A. Meldman

15.952–15.959 Special Seminars in Management
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Group study of current topics related to management not otherwise included in curriculum. 15.952 is taught P/D/F.
Consult Undergraduate Program Headquarters

15.956 Special Studies in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
15.961 Special Studies in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
For students who desire to do advanced work or to carry out some special investigation of a management problem not specifically covered elsewhere and not qualifying as a thesis. Readings, conferences, laboratory and fieldwork, and reports. Restricted to graduate students.
Consult Sloan Educational Services
15.962–15.971 Special Seminars in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

15.972–15.976 Special Seminars in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

15.977–15.979 Special Seminar in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Group study of current topics related to management not otherwise included in curriculum.
Consult Sloan Educational Services

15.980–15.985 Special Distance Learning Seminars in Management
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

15.986–15.989 Special Distance Learning Seminars in Management
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

Group study through distance learning on current topics related to management.
Consult Sloan Educational Services

15.990–15.993 Special Seminars in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

15.994–15.997 Special Seminars in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

Group study of current topics related to management not otherwise included in curriculum.
Consult Sloan Educational Services

15.999 Curricular Practical Training (CPT)
Prereq: None
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Students participate in off-campus work or internship experience and apply topics of management and/or culture to their experience. Requirements include mandatory attendance at one workshop and a paper. Students must have a formal employment offer prior to enrolling. Restricted to MIT Sloan students who have been in legal F1 status for nine consecutive months and who wish to work in the United States in an area related to their field of study.
Consult Sloan Educational Services

15.ThG Graduate Thesis
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Research and writing of thesis; to be arranged by the student with supervising committee.
Consult Sloan Educational Services
# Bachelor of Science in Management Science/Course 15

**General Institute Requirements (GIRs)**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [two subjects can be satisfied by 14.01 and 14.02 in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 6.041 and 18.06 in the Departmental Program]</td>
<td>8</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 15.301 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td>17</td>
</tr>
</tbody>
</table>

**Communication Requirement**

The program includes a Communication Requirement of 4 subjects:

- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Subjects</strong></td>
<td></td>
<td>123</td>
</tr>
<tr>
<td>1.00</td>
<td>Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)</td>
<td></td>
</tr>
<tr>
<td>6.041</td>
<td>Probabilistic Systems Analysis, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>14.01</td>
<td>Principles of Microeconomics, 12, HASS</td>
<td></td>
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<tr>
<td>14.02</td>
<td>Principles of Macroeconomics, 12, HASS</td>
<td></td>
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<tr>
<td>15.053</td>
<td>Optimization Methods in Management Science, 12</td>
<td></td>
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<tr>
<td>15.075</td>
<td>Statistical Thinking and Data Analysis, 12; 6.041*</td>
<td></td>
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<tr>
<td>15.279</td>
<td>Management Communication for Undergraduates, 12, CI-M</td>
<td></td>
</tr>
<tr>
<td>15.301</td>
<td>Managerial Psychology Laboratory, 15, LAB, CI-M</td>
<td></td>
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<tr>
<td>15.501</td>
<td>Corporate Financial Accounting, 12</td>
<td></td>
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<tr>
<td>18.06</td>
<td>Linear Algebra, 12, REST; Calculus II (GIR)</td>
<td></td>
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<tr>
<td></td>
<td><strong>Restricted Electives</strong></td>
<td>36–45</td>
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<tr>
<td></td>
<td>One of the following four subjects:</td>
<td></td>
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<tr>
<td>15.354</td>
<td>Innovation and Entrepreneurship: How to Do It, 9</td>
<td></td>
</tr>
<tr>
<td>15.401</td>
<td>Finance Theory I, 9</td>
<td></td>
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<tr>
<td>15.812</td>
<td>Marketing Management, 9</td>
<td></td>
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<tr>
<td>15.761</td>
<td>Introduction to Operations Management, 9; 6.041*</td>
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<td></td>
<td><strong>Concentration Subjects:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Three additional subjects as specified in one of the following concentrations: Finance, Information Technologies, Marketing Science, Operations Research</td>
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<tr>
<td></td>
<td><strong>Departmental Program Units That Also Satisfy the GIRs</strong></td>
<td>(60)</td>
</tr>
<tr>
<td></td>
<td><strong>Unrestricted Electives</strong></td>
<td>69–81</td>
</tr>
<tr>
<td></td>
<td><strong>Total Units Beyond the GIRs Required for SB Degree</strong></td>
<td>180</td>
</tr>
</tbody>
</table>

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student's departmental program will count toward one or the other, but not both.

**Notes**

* Alternate prerequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
16.001 Unified Engineering I
Prereq: Physics II (GIR); Coreq: 18.03 or 18.034; Chemistry (GIR)
U (Fall)
5-1-6
16.001 and 16.002 require simultaneous registration. Presents fundamental principles and methods of aerospace engineering, as well as their interrelationship and applications, through lectures, recitations, design problems, and labs. Materials and structures, including statics, analysis of trusses, the analysis of statically determinate and indeterminate systems, and the stress-strain behavior of materials. Fluid mechanics, including conservation laws for fluid flows, the integral momentum theorem and applications, potential flow, vorticity and circulation, and the characterization of airfoil performance. Thermodynamics, including the thermodynamic state of a system, work, heat and various forms of energy, the first law of thermodynamics, heat engines, reversible and irreversible processes, entropy, and the second law of thermodynamics. Signals and systems, including linear and time invariant systems, convolution, and transform analysis.

D. L. Darmofal, P. A. Lagacé, P. C. Lozano, E. H. Modiano

16.002 Unified Engineering II
Prereq: Physics II (GIR); Coreq: 18.03 or 18.034; Chemistry (GIR)
U (Fall)
5-1-6
16.001 and 16.002 require simultaneous registration. Presents fundamental principles and methods of aerospace engineering, as well as their interrelationship and applications, through lectures, recitations, design problems, and labs. Materials and structures, including statics, analysis of trusses, the analysis of statically determinate and indeterminate systems, and the stress-strain behavior of materials. Fluid mechanics, including conservation laws for fluid flows, the integral momentum theorem and applications, potential flow, vorticity and circulation, and the characterization of airfoil performance. Thermodynamics, including the thermodynamic state of a system, work, heat and various forms of energy, the first law of thermodynamics, heat engines, reversible and irreversible processes, entropy, and the second law of thermodynamics. Signals and systems, including linear and time invariant systems, convolution, and transform analysis.

D. L. Darmofal, P. A. Lagacé, P. C. Lozano, E. H. Modiano

16.003 Unified Engineering III
Prereq: 16.001 or 16.01; 16.002 or 16.02
U (Spring)
5-1-6
16.003 and 16.004 require simultaneous registration. Presents fundamental principles and methods of aerospace engineering, as well as their interrelationship and applications, through lectures, recitations, design problems, and labs. Materials and structures, including linear and time invariant systems, convolution, and transform analysis.

D. L. Darmofal, P. A. Lagacé, P. C. Lozano, E. H. Modiano

16.004 Unified Engineering IV
Prereq: 16.01 or 16.001; 16.02 or 16.002
U (Spring)
5-1-6
16.003 and 16.004 require simultaneous registration. Presents fundamental principles and methods of aerospace engineering, as well as their interrelationship and applications, through lectures, recitations, design problems, and labs. Materials and Structures, including analysis of beam bending, buckling and torsion, material and structural failure, including plasticity, fracture, fatigue, and their physical causes. Fluid Mechanics, including thin airfoil theory, three-dimensional wing theory, lifting line theory, induced drag and optimal lift distributions, wing design, aircraft performance, compressible flows, shocks, supersonic airfoils, nozzles. Thermodynamics and Propulsion, including applications of the integral momentum theorem to aerospace propulsion systems, ideal and non-ideal cycle analysis, energy exchange in compressors and turbines, and an introduction to heat transfer. Applications of signals and systems to aerospace, including modulation, filtering, sampling, and navigation systems.

D. L. Darmofal, J. Peraire, P. A. Lagacé, M. Z. Win
**Core Undergraduate Subjects**

**16.06 Principles of Automatic Control**  
Prereq: 16.004 or 16.04, Coreq: 16.07  
U (Fall)  
3-2-7  
Introduction to design of feedback control systems. Properties and advantages of feedback systems. Time-domain and frequency-domain performance measures. Stability and degree of stability. Root locus method, Nyquist criterion, frequency-domain design, and state space methods. Application to a variety of aircraft and spacecraft systems.  
_S. R. Hall_

**16.07 Dynamics**  
Prereq: 16.004 or 16.04, Coreq: 16.06  
U (Fall)  
3-1-8  
Fundamentals of Newtonian mechanics. Kinematics, particle dynamics, motion relative to accelerated reference frames, work and energy, impulse and momentum, systems of particles and rigid body dynamics. Applications to aerospace engineering including introductory topics in orbital mechanics, flight dynamics, inertial navigation and attitude dynamics.  
_S. E. Widnall_

**Mechanics and Physics of Fluids**

**16.100 Aerodynamics**  
Prereq: 16.004 or 16.04  
U (Fall)  
3-2-7  
Extends fluid mechanic concepts from Unified Engineering to aerodynamic performance of wings and bodies in sub/supersonic regimes. Subject generally has four components: subsonic potential flows, including source/vortex panel methods; viscous flows, including laminar and turbulent boundary layers; aerodynamics of airfoils and wings, including thin airfoil theory, lifting line theory, and panel method/intersecting boundary layer methods; and supersonic and hypersonic airfoil theory. Material may vary somewhat each year depending upon focus of design problem. Elementary MATLAB usage expected.  
_Y. M. Marrzouk_

**16.101 Special Subject in Fluids and Propulsion**  
Prereq: Permission of department  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit  
Provides credit for work on material in fluids or propulsion outside of regularly scheduled subjects. Intended for study abroad under either the department’s Year Abroad Program or the Cambridge-MIT Exchange Program. Credit may be used to satisfy specific SB degree requirements. Consult department.  
_B. C. Williams_

**16.110 Flight Vehicle Aerodynamics**  
Prereq: 16.100  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Spring)  
3-1-8  
_D. L. Darmofal_

**16.119 Advanced Special Subject in Mechanics and Physics of Fluids**  
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit  
Organized lecture or laboratory subject consisting of material not available in regularly scheduled fluids subjects.  
_Consult D. L. Darmofal_

**Materials and Structures**

**16.20 Structural Mechanics**  
Prereq: 16.004 or 16.04  
U (Spring)  
5-0-7  
_B. L. Wardle_

**16.201 Special Subject in Materials and Structures**  
Prereq: Permission of department  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit  
Provides credit for work in materials and structures outside of regularly scheduled subjects. Intended for study abroad under either the department’s Year Abroad Program or the Cambridge-MIT Exchange Program. Credit may
be used to satisfy specific SB degree requirements. Consult department.
B. C. Williams

16.202 Manufacturing with Advanced Composite Materials
Prereq: None
U (Fall)
1-3-2
Introduces the methods used to manufacture parts made of advanced composite materials with work in the Technology Laboratory for Advanced Composites. Students gain hands-on experience by fabricating, machining, instrumenting, and testing graphite/epoxy specimens. Students also design, build, and test a composite structure as part of a design contest. Lectures supplement laboratory sessions with background information on the nature of composites, curing, composite machining, secondary bonding, and the testing of composites.
P. A. Logacé

16.221J Structural Dynamics and Vibrations
(Same subject as 1.581J, 2.060J)
(Subject meets with 1.058)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 1.581J.
E. Kausel, J. K. Vandiver

16.223 Mechanics of Heterogeneous Materials
Prereq: 16.20, 16.288), or permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Mechanical behavior of heterogeneous materials such as thin-film microelectromechanical systems (MEMS) materials and advanced filamentary composites, with particular emphasis on laminated structural configurations. Anisotropic and crystallographic elasticity formulations. Structure, properties and mechanics of constituents such as films, substrates, active materials, fibers, and matrices including nano- and microscale constituents. Effective properties from constituent properties. Classical laminated plate theory for modeling structural behavior including extrinsic and intrinsic strains and stresses such as environmental effects. Introduction to buckling of plates and nonlinear (deformations) plate theory. Other issues in modeling heterogeneous materials such as fracture/failure of laminated structures.
B. L. Wardle

16.225J Computational Mechanics of Materials
(Same subject as 2.099J)
Prereq: Permission of instructor, programming in either C++, C, or Fortran
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-3-6 H-LEVEL Grad Credit
Formulation of numerical (finite element) methods for the analysis of the nonlinear continuum response of materials. The range of material behavior considered includes finite deformation elasticity and inelasticity. Numerical formulation and algorithms include variational formulation and variational constitutive updates; finite element discretization; constrained problems; time discretization and convergence analysis. Strong emphasis on the (parallel) computer implementation of algorithms in programming assignments. The application to real engineering applications and problems in engineering science are stressed throughout.
R. Radovitzky

16.230J Plates and Shells
(Same subject as 2.081J)
Prereq: 2.074, 2.080J, or 16.21
G (Spring)
3-0-3 H-LEVEL Grad Credit
See description under subject 2.081J.
T. Wierzbicki

16.288J Materials and Processes for Microelectromechanical Devices and Systems
(Same subject as 2.373J, 3.48J, 6.778J, 10.584J)
Prereq: 6.152J/3.155J; permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 3.48J.
L. Anand, K. F. Jensen, M. A. Schmidt,
C. V. Thompson, B. L. Wardle

16.298 Advanced Special Subject in Materials and Structures
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
16.299 Advanced Special Subject in Materials and Structures
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject- consisting of material not available in regularly scheduled materials and structures subjects.
Consult D. L. Darmofal

INFORMATION AND CONTROL ENGINEERING

16.30 Feedback Control Systems
(Subject meets with 16.31)
Prereq: 16.06, 16.060, 2.010, or 6.302
U (Fall)
3-0-9
Review of classical control design using root locus and frequency domain methods (Nyquist diagrams and Bode plots). State-space representation of dynamic systems, including model realizations, controllability, and observability. An introduction to the state-space approach to control system analysis and synthesis, including full state feedback using pole placement, state estimation, and the design of dynamic control laws. Performance limitations and robustness. Extensive use of computer-aided design tools. Applications to various aerospace systems including navigation, guidance, and control of vehicles. Students taking the graduate version complete additional assignments.
J. P. How

16.301 Special Subject in Control, Dynamics and Automation
Prereq: Permission of department
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Provides credit for work on material in control and/or dynamics and/or automation outside of regularly scheduled subjects. Intended for study abroad under either the department’s Year Abroad Program or the Cambridge-MIT Exchange Program. Credit may be used to satisfy specific SB degree requirements. Consult department.
B. C. Williams

16.31 Feedback Control Systems
(Subject meets with 16.30)
Prereq: 16.06 or 16.060
G (Fall)
3-0-9 H-LEVEL Grad Credit
Graduate-level version of 16.30; see description under 16.30. Includes additional homework questions, laboratory experiments, and a term project beyond 16.30 with a particular focus on the material associated with state-space realizations of MIMO transfer function (matrices); MIMO zeros, controllability, and observability; stochastic processes and estimation; limitations on performance; design and analysis of dynamic output feedback controllers; and robustness of multivariable control systems.
J. P. How
16.322 Stochastic Estimation and Control
Prereq: 16.06 or 16.060; 6.041 or 6.431
G (Spring)
3-0-9 H-LEVEL Grad Credit
S. R. Hall

16.333 Principles of Optimal Control
Prereq: 18.085, 16.31
G (Spring)
3-0-9 H-LEVEL Grad Credit
Studies basic optimization and the principles of optimal control. Considers deterministic and stochastic problems for both discrete and continuous systems. Solution methods include numerical search algorithms, model predictive control, dynamic programming, variational calculus, and approaches based on Pontryagin’s maximum principle. Includes many examples and applications of the theory.
J. P. How

16.333 Aircraft Stability and Control
Prereq: 16.31 or permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
E. Frazzoli

16.343 Spacecraft and Aircraft Sensors and Instrumentation
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Covers fundamental sensor and instrumentation principles in the context of systems designed for space or atmospheric flight. Systems discussed include basic measurement system for force, temperature, pressure; navigation systems (Global Positioning System, Inertial Reference Systems, radio navigation), air data systems, communication systems; spacecraft attitude determination by stellar, solar, and horizon sensing; remote sensing by incoherent and Doppler radar, radiometry, spectrometry, and interferometry. Also included is a review of basic electromagnetic theory and antenna design and discussion of design considerations for flight.
R. J. Hansman, D. W. Miller

16.346 Astrodynamics
Prereq: 18.03
G (Fall)
3-0-9 H-LEVEL Grad Credit
FUNDAMENTALS OF ASTRODYNAMICS; THE TWO-BODY ORBITAL INITIAL-VALUE AND BOUNDARY-VALUE PROBLEMS WITH APPLICATIONS TO SPACE VEHICLE NAVIGATION AND GUIDANCE FOR LUNAR AND PLANETARY MISSIONS INCLUDING BOTH POWERED AND MIDCOURSE MANEUVERS. TOPICS INCLUDE CELESTIAL MECHANICS, KEPLER’S PROBLEM, LAMBERT’S PROBLEM, ORBIT DETERMINATION, MULTI-BODY METHODS, MISSION PLANNING, AND RECURRENT ALGORITHMS FOR SPACE NAVIGATION. SELECTED APPLICATIONS FROM THE APOLLO, SPACE SHUTTLE, AND MARS EXPLORATION PROGRAMS.
R. H. Battin

16.35 Real-Time Systems and Software
Prereq: 1.00, 6.01, or 6.005
U (Spring)
3-0-9
Concepts, principles, and methods for specifying and designing real-time computer systems. Topics include concurrency, real-time execution implementation, scheduling, testing, verification, real-time analysis, and software engineering concepts. Additional topics include operating system architecture, process management, and networking.
N. Roy

(Same subject as ESD.355J)
Prereq: 16.35, 16.880J/ESD.33J, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
A reading and discussion subject on issues in the engineering of software systems and software development project design. Includes the present state of software engineering, what has been tried in the past, what worked, what did not, and why. Topics may differ each offering, but are chosen from the software process and lifecycle; requirements and specifications; design principles; testing, formal analysis, and reviews; quality management and assessment; product and process metrics; COTS and reuse; evolution and maintenance; team organization and people management; and software engineering aspects of programming languages.
N. G. Leveson

16.36 Communication Systems Engineering
Prereq: 16.004, 16.04, or 6.003; 6.041
U (Spring)
3-0-9
Introduces the fundamentals of digital communications and networking. Topics include elements of information theory, sampling and quantization, coding, modulation, signal detection and system performance in the presence of noise. Study of data networking includes multiple access, reliable packet transmission, routing and protocols of the Internet. Concepts discussed in the context of aerospace communication systems: aircraft communications, satellite communications, and deep space communications.
E. H. Modiano

16.37J Data-Communication Networks
(Same subject as 6.263J)
Prereq: 6.041 or 18.313
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.263J.
D. P. Bertsekas, E. Modiano

16.391J Statistics for Engineers and Scientists
(Same subject as 6.436J)
Prereq: Calculus II (GIR), 18.06, 6.431, or permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 6.436J.
M. Win, J. N. Tsitsiklis
16.395 Principles of Wide Bandwidth Communication
Prereq: A strong background in digital communication, e.g. 6.011, 16.36, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to the principles of wide bandwidth wireless communication, with a focus on ultra-wide bandwidth (UWB) systems. Topics include the basics of spread-spectrum systems, impulse radio, Rake reception, transmitted reference signaling, spectral analysis, coexistence issues, signal acquisition, channel measurement and modeling, regulatory issues, and ranging, localization and GPS. Consists of lectures and technical presentations by students.
M. Z. Win

16.398 Advanced Special Subject in Information and Control
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
16.399 Advanced Special Subject in Information and Control
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Intended for study abroad under either the department's Year Abroad Program or the Cambridge-MIT Exchange Program. Credit may be used to satisfy specific SB degree requirements. Consult department.
B. C. Williams

16.401 Special Subject in Communication and Software
Prereq: Permission of department
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Provides credit for student work on undergraduate-level material in communications and/or software outside of regularly scheduled subjects. Intended for study abroad under either the department's Year Abroad Program or the Cambridge-MIT Exchange Program. Credit may be used to satisfy specific SB degree requirements. Consult department.
B. C. Williams

16.405J Robotics: Science and Systems I
(Same subject as 6.141J)
Prereq: Permission of instructor
U (Spring)
2-6-4 Institute LAB
See description under subject 6.141J.
N. Roy, D. Rus, S. Teller

16.406J Robotics: Science and Systems II
(Same subject as 6.142J)
Prereq: 6.141 or permission of instructor
U (Fall)
2-6-4
See description under subject 6.142J.
D. Rus, S. Teller, N. Roy

16.410 Principles of Autonomy and Decision Making
(Subject meets with 16.413)
Prereq: 1.00 or 6.01
U (Fall)
4-0-8
Survey of reasoning, optimization and decision making methodologies for creating highly autonomous systems and decision support aids. Focus on principles, algorithms, and their application, taken from the disciplines of artificial intelligence and operations research. Reasoning paradigms include logic and deduction, heuristic and constraint-based search, model-based reasoning, planning and execution, and machine learning. Optimization paradigms include linear programming, integer programming, and dynamic programming. Decision-making paradigms include decision theoretic planning, and Markov decision processes.
B. C. Williams, E. Frazzoli

16.412J Cognitive Robotics
(Same subject as 6.836J)
Prereq: 6.043 or 6.042; and 16.410, 16.413, 6.034, or 6.825
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Algorithms and paradigms for creating a wide range of robotic systems that act intelligently and robustly, by reasoning extensively from models of themselves and their world. Examples range from autonomous Mars explorers and cooperative air vehicles, to everyday embedded devices. Topics include deduction and search in real-time; temporal, decision-theoretic and contingency planning; dynamic execution and re-planning; reasoning about hidden state and failures; reasoning under uncertainty, path planning, mapping and localization, and cooperative and distributed robotics. 8 Engineering Design Points.
B. C. Williams

16.413 Principles of Autonomy and Decision Making
(Subject meets with 16.410)
Prereq: 1.00 or 6.01
G (Fall)
3-0-9 H-LEVEL Grad Credit
Graduate-level version of 16.410; see description under 16.410. Additional material on reasoning under uncertainty and machine learning, including hidden Markov models, graphical models and Bayesian networks, computational learning theory, reinforcement learning, decision tree learning and support vector machines. Assignments include the application of autonomy algorithms to practical aerospace systems, as well as more advanced programming assignments.
B. C. Williams, E. Frazzoli

16.420 Planning Under Uncertainty
Prereq: 16.413
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Concepts, principles, and methods for planning with imperfect knowledge. Topics include state estimation, planning in information space, partially observable Markov decision processes, reinforcement learning and planning with uncertain models. Students will develop an understanding of how different planning algorithms and solutions techniques are useful in different problem domains. Previous coursework in artificial intelligence and state estimation strongly recommended.
N. Roy

HUMANS AND AUTOMATION

16.400 Human Factors Engineering
(Subject meets with 16.453J, ESD.773J)
Prereq: None. Coreq: 16.06
U (Fall)
3-3-6
Accidents associated with human error often reflect the failure to recognize human factors in the design stage. Interaction of humans with aircraft and other complex machines. Manual control and human-computer interaction in semi-automated vehicles. Reviews sensory, motor, and cognitive performance characteristics and derives human engineering design criteria. Principles of displays, controls and ergonomics applied in various class design exercises. Students taking graduate version complete different assignments.
M. L. Cummings

16.412 Principles of Autonomy and Decision Making
(Subject meets with 16.413)
Prereq: 16.410, 16.413, 6.034, or 6.825
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Algorithms and paradigms for creating a wide range of robotic systems that act intelligently and robustly, by reasoning extensively from models of themselves and their world. Examples range from autonomous Mars explorers and cooperative air vehicles, to everyday embedded devices. Topics include deduction and search in real-time; temporal, decision-theoretic and contingency planning; dynamic execution and re-planning; reasoning about hidden state and failures; reasoning under uncertainty, path planning, mapping and localization, and cooperative and distributed robotics. 8 Engineering Design Points.
B. C. Williams

16.413 Principles of Autonomy and Decision Making
(Subject meets with 16.410)
Prereq: 1.00 or 6.01
G (Fall)
3-0-9 H-LEVEL Grad Credit
Graduate-level version of 16.410; see description under 16.410. Additional material on reasoning under uncertainty and machine learning, including hidden Markov models, graphical models and Bayesian networks, computational learning theory, reinforcement learning, decision tree learning and support vector machines. Assignments include the application of autonomy algorithms to practical aerospace systems, as well as more advanced programming assignments.
B. C. Williams, E. Frazzoli

16.420 Planning Under Uncertainty
Prereq: 16.413
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Concepts, principles, and methods for planning with imperfect knowledge. Topics include state estimation, planning in information space, partially observable Markov decision processes, reinforcement learning and planning with uncertain models. Students will develop an understanding of how different planning algorithms and solutions techniques are useful in different problem domains. Previous coursework in artificial intelligence and state estimation strongly recommended.
N. Roy
16.422J Human Supervisory Control of Automated Systems
(Same subject as ESD.774J)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-1-8 H-LEVEL Grad Credit
Principles of supervisory control and telerobotics. Different levels of automation are discussed, as well as the allocation of roles and authority between humans and machines. Human-vehicle interface design in highly automated systems. Decision aiding. Trade-offs between human control and human monitoring. Automated alerting systems and human intervention in automatic operation. Enhanced human-computer and human intervention technologies such as virtual presence. Performance, optimization, and social implications of the human-automation system. Examples from aerospace, ground, and undersea vehicles, robotics, and industrial systems.

M. L. Cummings

16.423J Aerospace Biomedical and Life Support Engineering
(Same subject as ESD.65J, HST.515J)
Prereq: 16.400, 16.06, 16.060, or permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit
Fundamentals of human performance, physiology, and life support impacting engineering design and aerospace systems. Topics include effects of gravity on the muscle, skeletal, cardiovascular, and neurovestibular systems; human/pilot modeling and human/machine design; flight experiment design; and life support engineering for extravehicular activity (EVA). Case studies of current research are presented. Assignments include a design project, quantitative homework sets, and quizzes emphasizing engineering and systems aspects.

D. J. Newman

16.430J Sensory-Neural Systems: Spatial Orientation from End Organs to Behavior and Adaptation
(Same subject as HST.514J)
Prereq: Neuroscience or systems engineering or permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject HST.514J.

L. Young, C. Oman, D. Merfeld, C. Wall

16.453J Human Factors Engineering
(Same subject as ESD.773J)
(Subject meets with 16.400)
Prereq: None. Coreq: 16.06 or 2.010
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 16.400.

M. L. Cummings

16.456J Biomedical Signal and Image Processing
(Same subject as 6.55J, HST.582J)
Prereq: 6.003, 2.004, 16.004, or 18.085
G (Spring)
3-6-3 H-LEVEL Grad Credit
See description under subject HST.582J.

J. Greenberg, E. Adalsteinsson, W. Wells, G. Clifford

16.459 Bioengineering Journal Article Seminar
Prereq: None
G (Fall, Spring)
0-2-0
Can be repeated for credit
Each term, the class selects a new set of professional journal articles on bioengineering topics of current research interest. Some papers are chosen because of particular content, others are selected because they illustrate important points of methodology. Each week, one student leads the discussion, evaluating the strengths, weaknesses, and importance of each paper. Subject may be repeated for credit a maximum of four terms. Letter grade given in the last term applies to all accumulated units of 16.459.

C. M. Oman

16.470J Statistical Methods in Experimental Design
(Same subject as ESD.756J)
Prereq: 6.041 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Statistically based experimental design inclusive of forming hypotheses, planning and conducting experiments, analyzing data, and interpreting and communicating results. Topics include descriptive statistics, statistical inference, hypothesis testing, parametric and nonparametric statistical analyses, factorial ANOVA, randomized block designs, MANOVA, linear regression, repeated measures models, and application of statistical software packages.

M. L. Cummings

16.475J Human-Computer Interface Design Colloquium (New)
(Same subject as ESD.775J)
Prereq: None
G (Fall)
2-0-2
Provides guidance on design and evaluation of human-computer interfaces for students with active research projects. Roundtable discussion on developing user requirements, human-centered design principles, and testing and evaluating methodologies. Students present their work and evaluate each other’s projects. Readings complement specific focus areas. Team participation encouraged. Open to advanced undergraduates.

M. L. Cummings

16.498 Advanced Special Subject in Humans and Automation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

16.499 Advanced Special Subject in Humans and Automation
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects.

Consult D. L. Darmofal

PROPELLER AND ENERGY CONVERSION

16.50 Introduction to Propulsion Systems
Prereq: 16.004 or 2.005
U (Spring)
3-0-9
Presents aerospace propulsive devices as systems, with functional requirements and engineering and environmental limitations. Requirements and limitations that constrain design choices. Both air-breathing and rocket engines covered, at a level which enables rational integration of the propulsive system into an overall vehicle design. Mission analysis, fundamental performance relations, and exemplary design solutions presented.

A. H. Epstein
16.511 Aircraft Engines and Gas Turbines
Prereq: 16.50 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Performance and characteristics of aircraft engines and industrial gas turbines, as determined by thermodynamic and fluid mechanical behavior of components: inlets, compressors, combustors, turbines, and nozzles. Discusses various engine types, including turbojet, turbofan, and turboprop. Limitations imposed by material properties and stresses. Emphasizes future design trends, including reduction noise, pollutant formation, fuel consumption, and weight.

A. H. Epstein

16.512 Rocket Propulsion
Prereq: 16.50 or permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit


M. Martínez-Sánchez

16.522 Space Propulsion
Prereq: 8.03, 16.50; or permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit

Reviews rocket propulsion fundamentals. Discusses advanced concepts in rocket propulsion ranging from chemical engines to electrical engines. Topics include advanced mission analysis, physics and engineering of microrockets, solid propellant rockets, electrothermal, electrostatic, and electromagnetic schemes for accelerating propellant. Some coverage is given of satellite power systems and their relation to propulsion systems. Laboratory work emphasizes design and characterization of electric propulsion engines.

P. C. Lozano

16.540 Internal Flows in Turbomachines
Prereq: 2.25 or permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Internal fluid motions in turbomachines, propulsion systems, ducts and channels, and other fluid machinery. Useful basic ideas, fundamentals of rotational flows, loss sources and loss accounting in fluid devices, unsteady internal flow and flow instability, flow in rotating passages, swirling flow, generation of streamwise vorticity and three-dimensional flow, non-uniform flow in fluid components.

E. M. Greitzer

16.543 An Introduction to Acoustics of Fluid Flow
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Fundamentals of acoustics and aerodynamic sound with application to external and internal flows. Lighthill's acoustic analogy, effect of solid surfaces on acoustic behavior, effect of uniform and non-uniform mean flow, physics of jet noise, trailing edge noise theory, solutions to entropy, vorticity and acoustic field equations, characterization and estimation of noise sources encountered in turbomachinery and aircraft applications, innovative approaches to aircraft noise reduction.

Z. S. Spakovsky

16.55 Ionized Gases
Prereq: 8.03
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit


M. Martínez-Sánchez

16.58 Aircraft Gas Turbine Structures
Prereq: 16.511 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Examines the structural design of aircraft gas turbine engines as set by the (multidisciplinary) coupling between aerodynamic, thermal, and structural requirements for high-performance propulsion systems. Topics include structures under static loads, rotor dynamics and vibration (design of rotating blades and disks, critical speed of rotating shafts, flutter and forced response of compressor and turbine blades), low-cycle fatigue, and design considerations for hot-section components used in gas turbine engines.

A. H. Epstein, F. Ehrich, J. I. Hsia

16.598 Advanced Special Subject in Propulsion and Energy Conversion
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

16.599 Advanced Special Subject in Propulsion and Energy Conversion
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
H-LEVEL Grad Credit
Can be repeated for credit

Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects.

Consult D. L. Darmofal

OTHER UNDERGRADUATE SUBJECTS

16.URJ Undergraduate Research
Prereq: None
U (Fall, IAP, Spring)
Can be repeated for credit

16.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring)
Can be repeated for credit

Undergraduate research opportunities in aeronautics and astronautics. For further information, contact Manuel Martínez-Sánchez, departmental coordinator.

Staff

16.EPE UPOP Summer Practice Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 10.EPE, 16.EPE, 22.EPE)
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
Can be repeated for credit

See description under subject 2.EPE.

S. Luperfey
16.EPR UPOP Reflective Learning Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPR, 2.EPR, 3.EPR, 6.EPR, 10.EPR, 16.EPR, 22.EPR)
Prereq: 2.EPE or permission of instructor
U (Fall)
0-0-3 [P/D/F]
See description under subject 2.EPR. S. Luperfoy

16.EPW UPOP IAP Workshop
Engineering School-Wide Elective Subject
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW)
Prereq: None
U (IAP)
3-0-0 [P/D/F]
See description under subject 2.EPW. S. Luperfoy

16.621 Experimental Projects I
Prereq: None. Coreq: 16.06, 16.07
U (Fall, Spring)
2-1-3
First part of a two-term sequence addresses the conception and design of a student-selected experimental project carried out by a team. Principles of project hypothesis formulation and assessment, experimental measurements and error analysis, and effective report writing and oral presentation, with instruction both in-class and on an individual team basis. Selection and detailed planning of a research project, including in-depth design of components and equipment. Preparation of a detailed proposal for the selected project, which is then carried through to completion in 16.622.
E. M. Greitzer, J. L. Craig, R. F. Perdichizzi

16.622 Experimental Projects II
Prereq: 16.621, Coreq: 6.041
U (Fall, Spring)
1-7-4 Institute LAB
Execution of project experiments based on the designs developed in 16.621. Students construct their defined experiment, carry out experimental measurements of the relevant phenomena, analyze the data, and then apply the results to assess the hypothesis they developed previously. Written final report on the entire project and formal oral presentation. Includes instructions on effective report writing and oral presentation.
E. M. Greitzer, J. L. Craig, R. F. Perdichizzi

16.64 Flight Measurement Laboratory
Prereq: 16.02 or 16.020
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
2-2-2
Opportunity to see aeronautical theory applied in real-world environment of flight. Students assist in design and execution of simple engineering flight experiments in light aircraft. Typical investigations include determination of stability derivatives, verification of performance specifications, and measurement of navigation system characteristics. Restricted to students in Aeronautics and Astronautics.
R. J. Hansman

16.652 Inventions and Patents
Engineering School-Wide Elective Subject
(Offered under: 3.172, 6.901, 16.652)
Prereq: 14.02
U (Fall)
3-0-6
See description under subject 3.172.
Staff

16.653 Management in Engineering
Engineering School-Wide Elective Subject
(Offered under: 2.96, 6.930, 10.806, 16.653)
Prereq: None
U (Fall)
3-1-8
See description under subject 2.96.
H. S. Marcus

16.660 Introduction to Lean Six Sigma Methods (New)
(Same subject as ESD.62J)
(Subject meets with 16.853)
Prereq: None
U (IAP)
1-1-0 [P/D/F]
Covers the fundamental principles, practices and tools of lean six sigma methods that underlay modern organizational productivity approaches applied in aerospace, automotive, health care, and other sectors. Includes lectures, active learning exercises, a plant tour, talks by industry practitioners, and videos. One third of the course is devoted to a physical simulation of an aircraft manufacturing enterprise to illustrate the power of lean six sigma methods. Students taking the graduate version complete additional assignments.
A. L. Weigel, E. M. Murman

16.680 Undergraduate Special Project
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Opportunity to work on projects related to aerospace engineering outside the department. Consult department’s Academic Programs Office. B. C. Williams

16.681 Special Projects
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Study or laboratory project work by qualified students. Topics selected in consultation with the instructor.
B. C. Williams

16.682 Selected Topics in Aeronautics and Astronautics
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Study by qualified students. Topics selected in consultation with the instructor.
B. C. Williams

16.683 Aeronautics and Astronautics Seminars
Prereq: None
U (Fall, IAP, Spring)
2-0-0 [P/D/F]
Can be repeated for credit
Speakers from campus and industry discuss current activities and advances in aeronautics and astronautics. Restricted to Course 16 students.
B. C. Williams

16.687 Selected Topics in Aeronautics and Astronautics
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Study by qualified students. Topics selected in consultation with the instructor.
B. C. Williams
Overview of the global airline industry, focusing on recent industry performance, current issues and challenges for the future. Fundamentals of airline industry structure, airline economics, operations planning, safety, labor relations, airports and air traffic control, marketing, and competitive strategies, with an emphasis on the interrelationships among major industry stakeholders. Recent research findings of the MIT Global Airline Industry Program are showcased, including the impacts of congestion and delays, evolution of information technologies, changing human resource management practices, and competitive effects of new entrant airlines. Taught by faculty participants of the Global Airline Industry Program.


16.72 Air Traffic Control
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Introduces the various aspects of present and future Air Traffic Control systems. Descriptions of the present system: systems-analysis approach to problems of capacity and safety; surveillance, including NAS and ARTS; navigation subsystem technology; aircraft guidance and control; communications; collision avoidance systems; sequencing and spacing in terminal areas; future directions and development; critical discussion of past proposals and of probable future problem areas. Requires term paper.

H. Balakrishnan

16.75J Airline Management
(Same subject as 1.234J)
Prereq: 16.71J
G (Spring)
3-0-9 H-LEVEL Grad Credit

Overview of airline management decision processes, with a focus on economic issues and their relationship to operations planning models and decision support tools. Application of economic models of demand, pricing, costs, and supply to airline markets and networks. Examination of industry practice and emerging methods for fleet planning, route network design, scheduling, pricing and revenue management, with emphasis on the interactions between the components of airline management and profit objectives in competitive environments. Students participate in a competitive airline management simulation game as part of the subject requirements.

P. P. Belobaba

16.76J Logistical and Transportation Planning Methods
(Same subject as 1.203J, 6.281J, 15.073J, ESD.216J)
Prereq: 6.041
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 1.203J.


16.77J Airline Schedule Planning
(Same subject as 1.206J, ESD.215J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 1.206J.

C. Barnhart

16.78J Planning and Design of Airport Systems
(Same subject as 1.231J, ESD.224J)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

See description under subject 1.231J.

R. de Neufville, A. R. Odoni

16.798 Advanced Special Subject in Flight Transportation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

16.799 Advanced Special Subject in Flight Transportation
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects.

Consult D. L. Darmofal

AEROSPACE SYSTEMS

16.810J Engineering Design and Rapid Prototyping
(Same subject as ESD.035J)
Prereq: 16.01, 16.02 or 2.001, 2.002 or permission of instructor
U (IAP)
2-4-0

Develops initial competency in engineering design by taking a holistic view. Conceiving, designing, manufacturing and testing a system component such as a complex structural part. Activities include hand sketching, CAD modeling, CAE analysis, CAM programming, and operation of CNC machining equipment. Focuses on the complementary roles of human creativity as well as the design process itself. Designs are executed by pairs of students who enter their products in a design competition. Enrollment may be limited.

O. de Weck

16.82 Flight Vehicle Engineering
Prereq: Permission of department
U (Fall)
3-3-6

Design of an atmospheric flight vehicle to satisfy stated performance, stability, and control requirements. Emphasizes individual initiative, application of fundamental principles, and the compromises inherent in the engineering design process. Includes instruction and practice in written and oral communication, through team presentations and a written final report. Enrollment restricted to seniors in Course 16 who have satisfactorily completed all other departmental requirements for SB degree, or by permission of instructor.

R. J. Hansman, D. L. Miller

16.821 Flight Vehicle Development
Prereq: 16.82
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
2-10-6 Institute LAB

Implementation and operation of a flight system. Extension of the 16.82 project in the previous term. Emphasis is on system integration, implementation, and performance verification using methods of experimental inquiry. Includes refinement of subsystem designs and fabrication of working prototypes. Experimental analysis of subsystem performance and comparison with physical models of performance developed in 16.82 and design goals. Component integration into the full system, with detailed analysis and operation of the complete vehicle in the labora-
Communication skills are honed through written and oral reports. Formal reviews of the overall system design will be performed. Principles of laboratory safety. 

16.831 J Space Systems Development I
(Same subject as 12.431J)
Prereq: 16.83
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
2-6-4 1/2 Institute LAB

Students build the space system designed during the previous term in 16.83. Sub-system designs are refined and full-scale prototypes are fabricated. Sub-systems are integrated into a vehicle and tested. Sub-system performance is verified using methods of experimental inquiry, and is compared with physical models of performance developed in 16.83, and with design goals. Communication skills are honed through written and oral reports. Formal reviews include the Implementation Plan Review and the Acceptance Review.

D. W. Miller, J. Keesee, S. Seager

16.832 J Space Systems Development II
(Same subject as 12.432J)
Prereq: 16.831
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
1-5-0 1/2 Institute LAB

Students operate the space system built during the previous term in 16.831. Operation takes place both in the laboratory and the field. Activities include implementing modifications based upon first vehicle testing, and fabrication of remaining vehicles and system elements. Overall system performance verified using methods of experimental inquiry, and compared with physical models.

D. W. Miller, J. Keesee, S. Seager

16.831 Satellite Engineering
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Fundamentals of satellite engineering design, including distributed satellite. Studies orbital environment. Analyzes problems of station keeping, attitude control, communications, power generation, structural design, thermal balance, and subsystem integration. Considers trade-offs among weight, efficiency, cost, and reliability. Discusses choice of design parameters, such as size, weight, power levels, temperature limits, frequency, and bandwidth. Examples taken from current satellite systems.

D. W. Miller, J. A. Hoffman

16.851 J Integrating The Lean Enterprise
(Same subject as ESD.61J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Addresses some of the important issues involved with the planning, development, and implementation of lean enterprises. People, technology, process, and management dimensions of an effective lean manufacturing company are considered in a unified framework. Particular emphasis on the integration of these dimensions across the entire enterprise, including product development, production, and the extended supply chain. Analysis tools as well as future trends and directions are explored. A key component of this subject is a team project.

D. Nightingale

16.853 Introduction to Lean Six Sigma Methods
(New)
(Subject meets with 16.660J, ESD.62J)
Prereq: None
G (AP)
1-1-0 [P/D/F]

See description under subject 16.660J.

A. L. Weigel, E. M. Murman

16.855 J Enterprise Architecting
(Subject meets as ESD.38J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject ESD.38J.

D. Nightingale, D. Rhodes

16.861 Engineering Systems Analysis for Design
Engineering School-Wide Elective Subject
(Offered under: 1.146, 3.56, 16.861, ESD.71)
Prereq: 1.145) or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

See description under subject ESD.71.

R. de Neufville

16.862 Engineering Risk-Benefit Analysis
Engineering School-Wide Elective Subject
(Offered under: 1.155, 2.963, 3.577, 6.938, 10.816, 18.626, 22.82, ESD.72)
Prereq: Calculus II (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject ESD.72.

G. E. Apostolakis

16.863 J System Safety
(Same subject as ESD.863J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Covers important concepts and techniques in designing and operating safety-critical systems. Topics include the nature of risk, formal accident and human error models, causes of accidents, fundamental concepts of system safety engineering, system and software hazard analysis, designing for safety, fault tolerance, safety issues in the design of human-machine interaction, verification of safety, creating a safety culture, and management of safety-critical projects. Includes a class project involving the high-level system design and analysis of a safety-critical system.

N. G. Leveson

16.866J Cost Estimation and Measurement Systems
(Subject meets as ESD.361J)
Prereq: ESD.301 or a basic understanding of statistics and permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

See description under subject ESD.361J.

R. Valerdi
16.885 Aircraft Systems Engineering
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-1-8 H-LEVEL Grad Credit
Holistic view of the aircraft as a system, covering basic systems engineering, cost and weight estimation, basic aircraft performance, safety and reliability, life cycle topics, aircraft subsystems, risk analysis and management, and system realization. Small student teams retrospectively analyze an existing aircraft covering: key design drivers and decisions; aircraft attributes and subsystems; operational experience. Oral and written versions of the case study are delivered.

Focuses on a systems engineering analysis of the Space Shuttle. Studies both design and operations of the shuttle, with frequent lectures by outside experts. Students choose specific shuttle systems for detailed analysis and develop new subsystem designs using state of the art technology.

R. J. Hansman

16.886J Air Transportation Systems Architecting
(Same subject as ESD.351J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-2-7 H-LEVEL Grad Credit
Addresses the architecting of air transportation systems. Focuses on the conceptual phase of product definition including technical, economic, market, environmental, regulatory, legal, manufacturing, and societal factors. Centers on a realistic system case study and includes a number of lectures from industry and government. Past examples include the Very Large Transport Aircraft, a Supersonic Business Jet and a Next Generation Cargo System. Identifies the critical system level issues and analyzes them in depth via student team projects and individual assignments. Overall goal is to produce a business plan and a system specifications document that can be used to assess candidate systems.

R. J. Hansman, A. Haggerty, R. Liebeck

16.888J Multidisciplinary System Design Optimization
(Same subject as ESD.77J)
Prereq: 18.085 or permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-1-8 H-LEVEL Grad Credit
See description under subject ESD.77J.

O. de Weck, K. E. Willcox

16.891J Space Policy Seminar
(Same subject as ESD.129J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
explores current issues in space policy as well as the historical roots for the issues. Emphasis on critical policy discussion combined with serious technical analysis. Covers national security space policy, civil space policy, as well as commercial space policy. Issues explored include the GPS dilemma, the International Space Station choices, commercial launch from foreign countries, and the fate of satellite-based cellular systems.

A. L. Weigel

16.895J Space Systems Engineering
(Same subject as ESD.352J)
Prereq: 16.851, 16.892, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
4-2-6 H-LEVEL Grad Credit
Focus on developing space system architectures. Applies subsystem knowledge gained in 16.851 to examine interactions between subsystems in the context of a space system design. Principles and processes of systems engineering including developing space architectures, developing and writing requirements, and concepts of risk are explored and applied to the project. Subject develops, documents, and presents a conceptual design of a space system including a preliminary spacecraft design.

E. F. Crawley, D. W. Miller

16.898 Advanced Special Subject in Aerospace Systems
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit

16.899 Advanced Special Subject in Aerospace Systems
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects.
Consult D. L. Darmofal

COMPUTATION

16.90 Computational Methods in Aerospace Engineering
Prereq: 16.004 or permission of instructor;
Coreq: 6.041
U (Spring)
3-0-9
Introduction to computational techniques arising in aerospace engineering. Techniques include numerical integration of systems of ordinary differential equations; numerical discretization of partial differential equations; and probabilistic methods for quantifying the impact of variability. Specific emphasis will be given to finite volume methods in fluid mechanics, and energy and finite element methods in structural mechanics.

K. E. Willcox, Y. M. Marzouk

16.910J Introduction to Numerical Simulation
(Same subject as 2.096J, 6.336J)
Prereq: 18.03 or 18.06
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.336J.
L. Daniel, J. K. White

16.920J Numerical Methods for Partial Differential Equations
(Same subject as 2.097J, 6.339J)
Prereq: 18.03 or 18.06
G (Fall)
3-0-9 H-LEVEL Grad Credit
Covers the fundamentals of modern numerical techniques for a wide range of linear and nonlinear elliptic, parabolic, and hyperbolic partial differential and integral equations. Topics include mathematical formulations; finite difference, finite volume, finite element, and boundary element discretization methods; and direct and it-
AERONAUTICS AND ASTRONAUTICS

1.930 Advanced Topics in Numerical Methods for Partial Differential Equations
Prereq: 1.920
G (Spring)
3-0-9 H-LEVEL Grad Credit
Covers advanced topics in numerical methods for the discretization, solution, and control of problems governed by partial differential equations. Topics include the application of the finite element method to systems of equations with emphasis on equations governing compressible, viscous flows; grid generation; optimal control of PDE-constrained systems; a posteriori error estimation and adaptivity; reduced basis approximations and reduced-order modeling. Computer assignments require programming.
J. Peraire

1.948 Advanced Special Subject in Computation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

1.949 Advanced Special Subject in Computation
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects.
Consult D. L. Darmofal

1.980 Advanced Special Project
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

1.981 Advanced Special Project
Prereq: Permission of department
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Study, original investigation, or lab project work by qualified students. Topics selected in consultation with instructor.
Consult D. L. Darmofal

1.982 Advanced Special Subject
Prereq: Permission of department
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

1.983 Advanced Special Subject
Prereq: None
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects.
Consult D. L. Darmofal

1.984 Seminar
Prereq: None
G (Fall, Spring)
2-0-0 [P/D/F]
Can be repeated for credit
Discussion of current interest topics by staff and guest speakers. Restricted to Course 16 students.
D. L. Darmofal

OTHER GRADUATE SUBJECTS

16.980 Graduate Thesis
Prereq: Permission of department
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Program of research leading to an SM, EAA, PhD, or ScD thesis; to be arranged by the student with an appropriate MIT faculty member, who becomes thesis supervisor. Restricted to students who have been admitted into the department.
J. Peraire

16.981 Advanced Special Project
Prereq: Permission of department
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Study, original investigation, or lab project work by qualified students. Topics selected in consultation with instructor.
Consult D. L. Darmofal

16.982 Advanced Special Subject
Prereq: Permission of department
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

16.983 Advanced Special Subject
Prereq: None
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects.
Consult D. L. Darmofal

16.984 Seminar
Prereq: None
G (Fall, Spring)
2-0-0 [P/D/F]
Can be repeated for credit
Discussion of current interest topics by staff and guest speakers. Restricted to Course 16 students.
D. L. Darmofal

16.985 Proseminar in Manufacturing
(Same subject as 2.890J, 3.80J, 10.792J, 15.792J)
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
See description under subject 15.792.
D. B. Rosenfeld

16.999 Teaching Fellows Seminar
Prereq: Permission of instructor
G (Fall, IAP)
Units arranged [P/D/F]
Explore various aspects of teaching and learning through directed and follow-up reading, open dialogue, teaching practice and sharing of issues, concerns, and associated approaches. Topics include course planning and preparation, writing homework assignments and exams, assessment techniques of students and teaching, technology and teaching, working with students one-on-one, types/styles of teaching and learning, learning theories and cognitive development, and ethics and cheating. In-depth exploration of a topic chosen by each student through further reading, reflection, and possible application, and associated sharing and teaching with the class.
Consult Department Academic Services Office
Bachelor of Science in Aerospace Engineering/Course 16-1  
Bachelor of Science in Aerospace Engineering with Information Technology/  
Course 16-2

**General Institute Requirements (GIRs)**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied from among 1.00; 6.041; 18.03 or 18.034; and 16.001 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 16.622, 16.821, or 16.831/16.832 in the Departmental Program]</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**

17

**Communication Requirement**

The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M). See the Laboratory and Capstone section below for specific options.

**PLUS Departmental Program**

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics)

<table>
<thead>
<tr>
<th>Departmental Core (Required for students in both degree programs)</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.001 Unified Engineering I, 12, REST; Physics II (GIR), 18.03*, Chemistry (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>16.002 Unified Engineering II, 12; Physics II (GIR), 18.03*, Chemistry (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>16.003 Unified Engineering III, 12; 16.001, 16.002</td>
<td>12</td>
</tr>
<tr>
<td>16.004 Unified Engineering IV, 12; 16.001, 16.002</td>
<td>12</td>
</tr>
<tr>
<td>1.00 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>16.06 Principles of Automatic Control, 12; 16.004, 16.07</td>
<td>12</td>
</tr>
<tr>
<td>16.07 Dynamics, 12; 16.004, 16.06</td>
<td>12</td>
</tr>
<tr>
<td>6.041 Probabilistic Systems Analysis, 12, REST; Calculus II (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>18.03 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td>12</td>
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<tr>
<td>or</td>
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<tr>
<td>18.034 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td>12</td>
</tr>
</tbody>
</table>

**Professional Area Subjects**

All students must take at least 48 units from among the subjects designated by the department as Professional Area Subjects. The program must include subjects from at least three professional areas. Students in Course 16-1 must take at least 24 units from the Professional Area Subjects in Aerospace Engineering. Students in Course 16-2 must take at least 36 units from among the Professional Area Subjects in Aerospace Information Technology.

**Aerospace Engineering, 16-1**

*Fluid Mechanics*

16.100 Aerodynamics, 12; 16.004

*Materials and Structures*

16.20 Structural Mechanics, 12; 16.004

*Propulsion*

16.50 Introduction to Propulsion Systems, 12; 16.004*

*Computational Tools*

16.90 Computational Methods in Aerospace Engineering, 12; 16.004*; 6.041

**Aerospace Information Technology, 16-2**

*Estimation and Control*

16.30 Estimation and Control of Aerospace Systems, 12; 16.06*

*Computer Systems*

6.111 Introductory Digital Systems Lab, 12; 16.004*

16.35 Real-Time Systems and Software, 12; 1.00*

*Communications Systems*

16.36 Communication Systems Engineering, 12; 16.004*, 6.041

*Humans and Automation*

16.400 Human Factors Engineering, 12; 16.06

16.410 Principles of Autonomy and Decision Making, 12; 1.00*
Laboratory and Capstone Subjects

One of the following two subjects:
- **16.82** Flight Vehicle Engineering, 12, CI-M; permission of department
- **16.83** Space Systems Engineering, 12, CI-M; permission of department

Plus one of the following three sequences:

**Experimental Projects**
- **16.621** Experimental Projects I, 6; **16.06, 16.07**
- **16.622** Experimental Projects II, 12, LAB, CI-M; **16.621, 6.041**
  or
- Flight Vehicle Development
  **16.821** Flight Vehicle Development, 18, LAB, CI-M; **16.82**
  or
- Space Systems Development
  **16.831** Space Systems Development I, 12, LAB, CI-M; **16.83**
  **16.832** Space Systems Development II, 6, LAB; **16.831**

**Departmental Program Units That Also Satisfy the GIRs**

**Unrestricted Electives**

Total Units Beyond the GIRs Required for SB Degree

No subject can be counted both as part of the 17-subject GIRs and as part of the 198 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

**Notes**

* Alternate prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
POLITICAL PHILOSOPHY / SOCIAL THEORY

17.000J Political Philosophy
(Same subject as 24.611J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor
Systematic examination of selected issues in political philosophy. Topic changes each year.
S. Haslanger, R. Langton

17.006 Feminist Political Thought
(Subject meets with 17.007J, 24.237, SP.601J)
Prereq: Permission of instructor, based on previous coursework
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject SP.601J.

17.007J Feminist Political Thought
(Same subject as SP.601J)
(Subject meets with 17.006, 24.237)
Prereq: None
U (Spring)
3-0-9 HASS
See description under subject SP.601J.

17.03 Introduction to Political Thought
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Examines major texts in the history of political thought and considers how they contribute to a broader conversation about freedom, equality, democracy, rights, and the role of politics in human life. Philosophers include Plato, Aristotle, Machiavelli, Hobbes, Locke, Rousseau, Marx, Tocqueville, and Mill.

17.045J Power: Interpersonal, Organizational and Global Dimensions
(Same subject as 21A.245J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
See description under subject 21A.245J.
S. Silbey

POLITICAL ECONOMY

17.100J Political Economy I: Theories of the State and the Economy
(Same subject as 14.781J, 15.678J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Critical analysis of liberal, neoclassical, and Marxist perspectives on modern society. Alternative theories of economic growth, historical change, the state, classes, and ideology.
M. Piore, S. Berger

17.115 International Political Economy
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 HASS
Provides an introduction to the politics of international economic relations, including a range of analytical “lenses” to view the global economy. Examines the politics of trade policy, international monetary and financial relations, financial crises, foreign direct investment, third-world development and transition economies, the debate over “globalization,” and international financial crime.
D. Singer

17.125 The Politics of Global Financial Relations
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Explore effects of globalization of finance on international relations and domestic politics. Topics include international institutions and global governance; the multi-nationalization of production; effects of international capital markets on domestic politics; global finance and the developing world; and financial crises. Discussion of the interplay between politics and economics and the future of the nation-state.
D. Singer

17.135 Comparative Politics of Business-Government Relations (New)
Prereq: None
U (Spring)
3-0-9 HASS
Provides an in-depth comparative historical analysis of relations between business and government in a variety of economic, social, and political contexts. Focuses on selected developed and developing countries. Examines how government policy affects business practices, organization, and performance; and, conversely, how political activities by business affect the functioning and policy orientation of government.
B. Schneider

17.148 Political Economy of Globalization
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Analyzes the impact of trade and financial flows and regional integration on the domestic politics of advanced industrial states. Pressures for harmonization and convergence of domestic institutions and practices and the sources of national resistance to these are examined. Cases are drawn from both the advanced economies and developing countries.
S. Berger


17.156 Welfare and Capitalism in Western Europe (New)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Considers theoretical models that attempt to capture the distinct paradigms of capitalism and welfare regimes prevalent in Western European economies. Analyzes content and processes of contemporary changes in the political economy and social policy—from a broad view of the challenges, to closer inquiry into specific reforms. Includes a theoretical discussion of how change occurs and trajectories of development.

K. Thelen

17.176j Economic Development and Policy Analysis I
(Same subject as 11.491J)
Prereq: 11.701
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 11.491J.

A. Amsden

17.178 Institutional Foundations of Capitalist Development (New)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Explores institutional diversity in capitalist development and various explanations (e.g. economic, institutional, sociological, and political) for the divergent economic organization. Examines dimensions of comparison, including issues in corporate governance, business-government relations, labor relations, vocational training, and multinational corporations. Also considers global production networks, natural resource dependence, finance, diversified business groups, industrial policy, and globalization.

B. Schneider

17.181 Sustainability: Political Economy, Science, and Policy
(Subject meets with 17.182)
Prereq: None
U (Spring)
3-0-9 HASS

17.182 Sustainability: Political Economy, Science, and Policy
(Subject meets with 17.181)
Prereq: None
G (Spring)
3-0-9

Examines alternative conceptions and theoretical underpinnings of sustainable development. Focuses on the sustainability problems of industrial countries, and of developing states and economies in transition. Explores the sociology of knowledge regarding sustainability, the economic and technological dimensions, and institutional imperatives. Considers implications for political constitution of economic performance. 17.181 fulfills undergraduate public policy requirement in the major and minor. Graduate students are expected to explore the subject in greater depth through reading and individual research.

N. Choucri

17.184j Economic Institutions and Growth Policy Analysis
(Same subject as 11.486J, 14.778J)
Prereq: 11.203
G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject 11.486J.

A. Amsden, M. Piore

17.188j Labor and Politics
(Same subject as 11.414J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9

Examines issues facing labor in today's global world through research and reading. Recent developments (globalization, liberalization, privatization) have created a mix of opportunities and risks for labor in most developing countries. On the one hand, these trends have encouraged foreign direct investment and the diffusion of global supply chains, which in turn, have promoted economic development and job growth for some groups of workers in some of these countries. On the other hand, globalization and liberalization have undermined social safety nets, eroded labor and environmental standards, and resulted in greater rates of poverty for other groups of workers in other developing countries. How do we explain these differences?

What kinds of policies can be promoted to more evenly distribute the benefits of globalization? Subject seeks to address these two questions.

R. Locke

17.190j Economic Development and Policy Analysis, Part II
(Same subject as 11.492J)
Prereq: 11.491J
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 11.492J.

A. Amsden

17.195 Globalization
(Subject meets with 17.196)
Prereq: Permission of instructor
U (Fall)
3-0-9 HASS

17.196 Globalization
(Subject meets with 17.195)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Analyzes changes in the international economy and their effects in the politics, economy, and society of advanced and emerging countries. Topics include the independence of national governments; wage inequality; unemployment; industrial production outside national borders and its consequences for innovation, efficiency, and jobs; fairness in trade; and mass culture versus local values. 17.195 fulfills undergraduate public policy requirement in the major and minor. Graduate students are expected to explore the subject in greater depth.

S. Berger

17.199j Working in a Global Economy
(Same subject as 21F.098J)
Prereq: Permission of instructor
U (Fall)
3-0-9 HASS, CI-H

For students who have already experienced work and research in today's global economy. Offers an introduction to core concepts used to understand developments and interdependencies in the new global economy through a combination of conceptual approaches and practical case studies. Combines a broad range of interactive classroom experiences including student presentations and guest speakers from business and academia with hands-on knowledge of how the global economy operates. Explores issues such as global entrepreneurship, the rise of global challengers like India and China, and cross-cultural communication in multinational organizations. Enrollment limited.

S. Berger, S. Sferza
**American Politics**

17.20 Introduction to the American Political Process
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 4, CI-H
Studies American government, emphasizing the institutions of government and the representation of competing interests. Topics include the founding, constitutional interpretation, legislative processes, presidential power, public opinion and voting, group mobilization, political steering of the bureaucracy and the economy, and federalism.

G. Lenz

17.200 Graduate Seminar in American Politics I
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Analyzes mass political behavior within the American political system. Examines political ideology, party identification, public opinion, voting behavior, media effects, racial attitudes, mass-elite relations, and opinion-policy linkages. Surveys and critiques the major theoretical approaches and empirical research in the field of political behavior.

A. Campbell

17.202 Graduate Seminar in American Politics II
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Analyzes the institutions of the American political system, with primary emphasis on the national level. Examines American federalism, political parties, national political institutions, and the policymaking process. Focuses on core works in contemporary American politics and public policy. Critiques both research methodologies and the explicit and implicit theoretical assumptions of such work.

C. Stewart

17.244 Media Politics
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring) 3-0-9
The mass media are crucial players in modern democratic government, but most people have only a fuzzy understanding of their role and influence. Subject examines why the media cover what they do; how their coverage influences the behavior of politicians and public officials; and how it shapes the attitudes of ordinary people.

G. Lenz

17.249 Law and Society
(Same subject as 11.163J, 21A.219J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring) 3-0-9 HASS, CI-H
See description under subject 21A.219J.

S. Silbey

17.251 Congress and the American Political System I
(Subject meets with 17.252)
Prereq: 17.20 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall) 3-0-9 HASS

17.252 Congress and the American Political System I
(Subject meets with 17.251)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall) 3-0-9 H-LEVEL Grad Credit
Focuses on the internal processes of the House and Senate and on the place of Congress in the American political system. Attention to committee behavior, leadership patterns, and informal organization. Considers relations between Congress and other branches of government, as well as relations between the two houses of Congress itself. Graduate students are expected to pursue the subject in greater depth through reading and individual research.

C. Stewart

17.261 Congress and the American Political System II
(Subject meets with 17.262)
Prereq: 17.251 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring) 3-0-9 HASS

17.262 Congress and the American Political System II
(Subject meets with 17.261)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring) 3-0-9 H-LEVEL Grad Credit
Analyzes the development of the US Congress by focusing on the competing theoretical lenses through which legislatures have been studied. Particularly compares sociological and economic models of legislative behavior, applying those models to floor decision-making, committee behavior, political parties, relations with other branches of the federal government, and elections. Graduate students expected to pursue the subject in greater depth through reading and individual research.

C. Stewart

17.263 Electoral Politics
Prereq: 17.20
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall) 3-0-9 HASS
Considers the role of elections in American politics. Issues explored include empirical and theoretical models of electoral competition, the effect of elections on public policy, and proposals to improve elections. Special emphasis is given to mass voting behavior, political parties, the media, and campaign finance. Subject focuses on US elections, but provides some contrasts with other countries, especially the United Kingdom.

G. Lenz

17.264 Electoral Politics
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall) 3-0-9 H-LEVEL Grad Credit
Analyzes elections in light of theories about voters, parties, and candidates. Topics include election laws and reforms, and the formation of governments. Focus is mainly on US elections, though other democracies are also examined. Familiarity with statistics recommended but not required. Open to qualified undergraduates.

G. Lenz
17.265 Public Opinion and American Democracy
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Introduces students to public opinion in politics and public policy-making. Surveys theories of political psychology and political behavior. Examines empirical research on public understanding of and attitudes towards important issues, including war, economic and social policies, and moral questions.
A. Berinsky, A. Campbell

17.266 Public Opinion
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Provides an introduction to the scholarly literature devoted to public opinion. Surveys the major theoretical approaches and empirical research in the field of political behavior. Topics include mass-elite relations, racial politics, political ideology, public opinion and war, public opinion and public policy and media effects. Primarily focuses on American public opinion, though research on comparative public opinion is also covered.
A. Berinsky

17.270 American Political Development
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Examines the evolution of American national political processes over time: how political culture, governing institutions, and structures of political linkage (parties and organized interests) shape political conflict and public policy. Topics include the evolution of electoral politics and the party system, eras of political reform and state expansion (Populist, Progressive, New Deal, and Great Society), major wars and their effects, and the adaptation of government institutions to crisis and complexity in society and in the economy. Open to undergraduates with permission of instructor.
A Campbell

17.276 Public Opinion Research Training Lab
Prereq: 17.800 and 17.266; or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Follows 17.266. Offers practical training in public opinion research and provides students with an opportunity to conduct their own survey research. As a group, students design a national sample survey and field the survey. Students analyze the survey results and examine literatures related to the content of the survey. Ideal for second and third year PhD students and advanced undergraduates, though others are welcome.
A. Berinsky, A. Campbell

17.281 Public Opinion and Foreign Policy
(Subject meets with 17.282)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
17.282 Public Opinion and Foreign Policy
(Subject meets with 17.281)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Examines the nature of public opinion on foreign policy, the ability of the public to formulate reasoned and interconnected perspectives on the issues of the day, and the public’s influence on foreign policy decisions. Main focus is on the United States. The role of the media and international events in shaping public perspectives and public attitudes toward important issues such as internationalism and isolationism, the use of force, and trade are evaluated. Students taking graduate version are expected to complete additional assignments.
A. Berinsky

17.290J Making Public Policy
(Same subject as 11.002J)
Prereq: None
U (Fall)
4-0-8 HASS-D, Category 4, CI-H
See description under subject 11.002J.
J. Layzer, A. Campbell

17.307 American Public Policy for Washington Interns
Prereq: Permission of instructor
U (Fall, Spring)
3-0-9 HASS
Examines US policy-making process, with special attention to making of policy for science and technology. Subject spans Spring and Fall terms. Spring term attends to origins and development of American policymaking institutions and their roles in settling controversial policy questions. Fall term focuses on development of representative policies in the US, such as pollution controls, biotechnical engineering, and telecommunications. Selection and participation in Washington Summer Internship program required. Fulfills undergraduate public policy requirement in the major and minor.
C. Stewart

17.309J Science, Technology, and Public Policy
(Same subject as STS.082J)
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
4-0-8 HASS, CI-H
Analysis of issues at the intersection of science, technology, public policy, and business. Cases drawn from antitrust and intellectual property rights; health and environmental policy; defense procurement and strategy; strategic trade and industrial policy; and R&D funding. Structured around theories of political economy, modified to take into account integration of uncertain technical information into public and private decision-making. Limited to 18.
K. Oye

17.310J Science, Technology, and Public Policy
(Same subject as ESD.103J, STS.482J)
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Analysis of issues at the intersection of science, technology, public policy, and business. Cases drawn from antitrust and intellectual property rights; health and environmental policy; defense procurement and strategy; strategic trade and industrial policy; and R&D funding. Structured around theories of political economy, modi-
fied to take account of integration of uncertain technical information into public and private decision-making.

K. Oye

17.311 Politics, Race, and Science
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Comparatively examines the historical and contemporary role of science in constructing knowledge about human differences and similarities in terms of race. Particular attention is paid to the social and political context of scientific inquiry and to its consequences for public policy. Topics include US “Jim Crow” segregation policy, US immigration policy, the US eugenics movement, and the international Human Genome Project.

M. Nobles

17.312 Integrating Doctoral Seminar on Emerging Technologies
(Same subject as ESD.85J, STS.461J)
Prereq: Permission of instructor
G (Spring)
2-0-7 H-LEVEL Grad Credit
See description under subject ESD.85J.
K. Oye

17.314 Labor Market Regulation and Career Mobility
(Same subject as 14.665J)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Examines the way in which workers organize to structure and regulate the labor market and how those efforts interact with (as cause and effect) career mobility. Particular focus on the contrast between union organization and government regulation and on the shift from mobilization around class to mobilization around race, sex and ethnicity. Contrast between unified systems of regulation (France, Spain, Latin America) and fragmented systems (United States).

Consult M. Piore

17.315 Health Policy
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Analyzes the health policy problems facing America including adequate access to care, the control of health care costs, and the encourage-

International Relations

17.40 American Foreign Policy: Past, Present, and Future
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 4, CI-H

Reasons for America’s past wars and interventions. Consequences of American policies. Evaluation of these consequences for the US and the world. History covered includes World Wars I and II, the Korean and Indochina wars, the Cuban Missile Crisis and current conflicts, including those in in Iraq and Afghanistan, and against al Qaeda.

S. Van Evera

17.405 Seminar on Politics and Conflicts in the Middle East
(Subject meets with 17.406)
Prereq: None
U (Fall)
3-0-9 HASS

17.406 Seminar on Politics and Conflicts in the Middle East
(Subject meets with 17.405)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Focuses on evolution of contemporary politics and economics. Subject divided into five parts: historical context of conflicts; domestic and regional politics; civil and cross-border conflicts; geopolitical challenges; conflict resolution and peace processes. Interactions and spillover effects explored, and alternative models of conflict(s) designed. Graduate students are expected to pursue the subject in greater depth through reading and individual research.

N. Choucri
17.407 Chinese Foreign Policy  
(Subject meets with 17.408)  
Prereq: Permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Spring)  
3-0-9 HASS

17.408 Chinese Foreign Policy  
(Subject meets with 17.407)  
Prereq: Permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Spring)  
3-0-9 H-LEVEL Grad Credit

Examines the sources of China's foreign and security policy, past and present. Seminar places particular emphasis on the role of strategy and warfare in China's interactions with other states. Readings include primary sources such as Sun Zi's Art of War, as well as key secondary works on China's diplomatic and military history covering the periods before and after 1949. Graduate students are expected to explore material in greater depth. Exposure to international relations of Chinese politics required.  
* M. T. Fravel

17.410 Globalization, Migration, and International Relations  
(Subject meets with 17.411)  
Prereq: Permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Spring)  
3-0-9 H-LEVEL Grad Credit

17.411 Globalization, Migration, and International Relations  
(Subject meets with 17.410)  
Prereq: None  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Spring)  
3-0-9 HASS

Tracing the evolution of international interactions, subject examines the dimensions of globalization in terms of scale and scope. Includes international environmental issues, impacts and expansion of human activities, and the potential implications for global and national policy. Linkages among individuals, nation-states, transnational organizations and firms, international systems, and the global environment. Special focus on models of globalization, challenges of sustainable development, and on evolving types. Institutional responses to globalization and global change. 17.411 fulfills undergraduate public policy requirement in the major and minor. Graduate students are expected to explore the subject in greater depth through reading and individual research.  
* N. Choucri

17.418 Field Seminar in International Relations Theory  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit

Provides an overview of the field of international relations. Each week a different approach to explaining international relations is examined. Surveys major concepts and theories in the field to assist in the preparation for further study in the department's other graduate offerings in international relations.  
* M. T. Fravel

17.42 Causes and Prevention of War  
Prereq: None  
U (Spring)  
4-0-8 HASS-D, Category 4, CI-H

Examines the causes of war, with a focus on practical measures to prevent and control war. Topics include causes and consequences of misconception by nations; military strategy and policy as cause of war; religion and war; US foreign policy as a cause of war and peace; and the likelihood and possible nature of great wars in the future. Historical cases include World War I, World War II, the Korean War, the Seven Years' War, the Arab-Israel conflict, other recent Mideast wars, and the Peloponnesian War.  
* S. Van Evera

17.420 Advances in International Relations Theory  
Prereq: Permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Fall)  
3-0-9 H-LEVEL Grad Credit

Critical analysis of contending theories of international relations. Focus is on alternative theoretical assumptions, different analytical structures, and a common core of concepts and content. Comparative analysis of realism(s), liberalism(s), institutionalism(s), and new emergent theories. Discussion of connections between theories of international relations and major changes in international relations. Open to undergraduates by permission of instructor.  
* N. Choucri

17.422 Field Seminar in International Political Economy  
Prereq: Permission of instructor  
Acad Year 2009–2010: G (Fall)  
Acad Year 2010–2011: Not offered  
3-0-9 H-LEVEL Grad Credit

Review of IPE field covering previous and core research focusing on dual national objectives in a global context, namely pursuit of power and pursuit of wealth. Surveys major paradigms of international political economy, including neoclassical economics, marxist economics, development and ecological economics, lateral pressure, and perspectives and structural views of power relations. Examines interaction of politics and economics on international trade, capital flows, foreign investment, intellectual property rights, international migration, and select issues in foreign economic policy in global context. Examines the evolution of international economic institutions and attendant political implications. Open to undergraduates by permission of instructor.  
* N. Choucri

17.424 International Political Economy of Advanced Industrial Societies  
Prereq: Permission of instructor  
Acad Year 2009–2010: G (Fall)  
Acad Year 2010–2011: Not offered  
3-0-9 H-LEVEL Grad Credit

Focuses analytically on how interest groups, voters, political parties, electoral institutions, ideas and power politics interact to shape policy outcomes. Topics covered include globalization, international trade, international monetary and financial relations, and economics, and security.  
* D. Singer

17.428 American Foreign Policy: Theory and Method  
Prereq: Permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Fall)  
3-0-9 H-LEVEL Grad Credit

Examines the causes and consequences of American foreign policy since 1898. Readings cover theories of American foreign policy, historiography of American foreign policy, central historical episodes including the two World Wars and the Cold War, case study methodology, and historical investigative methods. Open to undergraduates by permission of instructor.  
* S. Van Evera

17.430 Research Seminar in International Relations  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit

While this seminar provides an overview of recent literature, its principal purpose is to help graduate students develop skills suited to production of research papers and/or dissertations. Begins by reviewing general theoretical and methodological issues, then turns to specific empirical studies that examine the effects of systems structure, national attributes, bargain-
ing processes, institutions, ideas, and norms on security affairs and political economy. The last two sessions of the seminar are devoted to evaluating research proposals generated by all members of the class.

K. Oye

17.432 Causes of War: Theory and Method
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Examines the causes of war. Major theories of war are examined; case study and large-n methods of testing theories of war are discussed; and the case study method is applied to several historical cases. Cases covered include World Wars I and II. Open to undergraduates only by permission of instructor.

S. Van Evera

17.433 International Relations of East Asia
(Subject meets with 17.434)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

17.434 International Relations of East Asia
(Subject meets with 17.433)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9

Introduces and analyzes the international relations of East Asia. Examines the sources of conflict and cooperation during and after the Cold War, assessing competing explanations for key events in East Asia’s international relations. Readings drawn from international relations theory, political science and history.

M. T. Fravel

17.436 Territorial Conflict
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9

Examines why territorial conflicts arise in the first place, why some of these conflicts escalate to high levels of violence and why other territorial disputes reach settlement, thereby reducing a likely source of violence between states. Readings drawn upon political geography and history as well as qualitative and quantitative approaches to political science.

M. T. Fravel

17.440 Global Governance
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Research seminar explores the concept of governance at the international level, including the design and function of international institutions and organizations, the role of international law, the rise of transnational actors, and the relationship between domestic politics and international cooperation. Readings also include empirical studies of cooperation in a variety of issue areas, including the environment, human rights, economic affairs, and security.

D. Singer

17.441 International Politics and Climate Change
(Subject meets with 17.442)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

17.442 International Politics and Climate Change
(Subject meets with 17.441)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9

Focuses on critical interconnections of international politics and climate change. Beginning with the 20th-century environmental and strategic legacies, examines politicization of the natural environment and the role of science in this process; types of conflicts and threats to security traced to climate change; and emergent global accords in response to mounting evidence of climate change. The course concludes by addressing the question of what is next for theory and policy. Students taking the graduate version complete additional assignments.

N. Choucri

17.447j Nuclear Forces and Missile Defenses
(Same subject as 17.476)
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 HASS

Introduces the assessment of strategic nuclear forces. Emphasizes the development of force requirements and methods for analyzing alternative force postures in terms of missions, effectiveness, and cost. The history of the US-Soviet strategic competition provides the backdrop against which the evolution of nuclear strategy and forces is considered. Students taking graduate version are expected to complete additional assignments.

T. Postol

17.448j Technology and Policy of Weapons Systems
(Same subject as STS.076)
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 HASS

See description under subject STS.076j.

T. Postol

17.476 Great Power Military Intervention
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Examines systematically, and comparatively, great and middle power military interventions, and candidate military interventions, into civil wars since 1991. These civil wars did not easily fit into the traditional category of vital interest. These interventions may therefore tell us something about broad trends in international politics including the nature of unipolarity, the erosion of sovereignty, the security implications of globalization, and the nature of modern western military power.

B. Posen

17.477j Political Economy of World Order
(Same subject as STS.435)
Prereq: None
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: G (Fall)
3-0-9 HASS

Examines how the intellectual, institutional, and political bases of world order have changed during the post-Cold War period. Focuses on the role of states and non-state actors in creating and maintaining stable international order.

T. Postol

Security Studies

17.468 Foundations of Security Studies
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Develops a working knowledge of the theories and conceptual frameworks that form the intellectual basis of security studies as an academic discipline. Particular emphasis on balance of power theory, organization theory, civil-military relations, and the relationship between war and politics. The reading list includes Jervis, Schelling, Waltz, Blainey, von Clausewitz, and Huntington. Students will write a seminar paper in which theoretical insights are systematically applied to a current security issue.

B. Posen
17.482 US Military Power
(Subject meets with 17.483)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

17.483 US Military Power
(Subject meets with 17.482)
Prereq: Freshmen need permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Examine the evolving roles and missions of US General Purpose Forces within the con- text of modern technological capabilities and Grand Strategy, which is a conceptual system of interconnected political and military means and ends. Topics include US Grand Strategies; the organization of the US military; the defense budget; and the capabilities and limitations of naval, air, and ground forces. Also examine the utility of these forces for power projection and the problems of escalation. Analyzes military history and simple models of warfare to explore how variations in technology and battlefield conditions can drastically alter effectiveness of conventional forces. 17.483 fulfills undergraduate public policy requirement in the major and minor. Graduate students are expected to explore the subject in greater depth.

B. Posen

17.484 Comparative Grand Strategy and Military Doctrine
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

A comparative study of the grand strategies and military doctrines of the great powers in Europe (Britain, France, Germany, and Russia) from the late 19th to the mid-20th century. Examines strategic developments in the years preceding and during World Wars I and II. What factors have exerted the greatest influence on national strategies? How may the quality of a grand strategy be judged? Exploration of comparative case study methodology also plays a central role. What consequences seem to follow from grand strategies of different types? Open to undergraduates with permission of instructor.

B. Posen

17.486 Japan and East Asian Security
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Explores Japan’s role in world orders, past, present, and future. Focuses on Japanese conceptions of security; rearmament debates; the relationship of domestic politics to foreign policy; the impact of Japanese technological and economic transformation at home and abroad; alternative trade and security regimes; Japan’s response to 9/11; and relations with Asian neighbors, Russia, and the alliance with the United States.

R. J. Samuels

17.500 Introduction to Comparative Politics
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 4, CI-H

Examines why democracy emerges and survives in some countries rather than in others; how political institutions affect economic development; and how American politics compares to that of other countries. Reviews economic, cultural, and institutional explanations for political outcomes. Includes case studies of politics in the US, Germany, Italy, Mexico, and Iraq, with less detailed discussion of other countries in different regions of the world. Assignments include several papers of varying lengths and extensive structured and unstructured class participation.

C. Lawson, M. Nobles

17.504 Ethnic Politics I
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
4-0-8 H-LEVEL Grad Credit

17.506 Ethnic Politics II
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
4-0-8 H-LEVEL Grad Credit

Introduces students to the classic works on ethnic politics, familiarizes them with new research and methodological innovations in the study of ethnic politics, and helps them design and execute original research projects related to ethnic politics. Readings drawn from across disciplines, including political science, anthropology, sociology, and economics. Students read across the four subfields within political science. Graduate students specializing in any subfield are encouraged to take this subject, regardless of their previous empirical or theoretical background. Designed as a year-long research workshop, but may also be taken in either term.

R. Petersen, M. Nobles

17.509 Social Movements in Comparative Perspective
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Explores why people join grassroots political organizations and social movements. Examines how accounts for the ultimate success or failure of these organizations and examines how social movements have altered political parties, political institutions, and social relations. Critically considers a range of theoretical treatments and several movements, including the U.S. civil rights, poor peoples’, pro-life/pro-choice and gay/lesbian movements.

M. Nobles

17.515 Comparative Electoral Politics
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Subject discusses classic and current issues in electoral politics. Focus is mostly thematic, although the topics will be discussed in the context of different countries and regions. Examples of the topics are: party systems, old and new political cleavages, representation, electoral systems, and immigration and its effect on the party system. Two country-specific case studies explored in depth.

O. Kedar

17.516 Transitional Justice
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Emerging democracies are now confronted with what has been termed “the torturer problem.” The questions are old ones: What is to be done about the perpetrator(s) and what is to be done for the abused? Seminar broadly examines the theoretical and empirical approaches to understanding the issues commonly associated with “transitional justice,” including its motivations, agents, institutions, and decisions. Cases are drawn from various countries and historical periods, including post-World War II Europe, 19th-century America, and 20th-century Africa and Latin America.

M. Nobles
17.517 Participation in Public Life
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Examines how and why people participate in public life and political affairs. Drawing on examples from around the world, students analyze the effects of social networks, community norms, and associational activities on the functioning of democracy, regime stability, state capacity, and international politics.

S. Berger

17.523 Ethnic Conflict in World Politics
Prereq: None
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9 HASS
Ethnic and racial conflict appear to be the hallmark of the post-Cold War world. Students explore the rise of ethnic/racial and nationalist sentiments and movements; the basis of ethnic and racial identity; the political claims and goals of such movements, and whether conflict is inevitable. Introduces the dominant theoretical approaches to race, ethnicity, and nationalism, and considers them in light of current events in Africa, Europe, Asia, and the Americas.

M. Nobles

17.526 Dissertation Workshop in Comparative Politics and Comparative Political Economy
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Designed for PhD students embarking on dissertation research in the fields of comparative politics and comparative political economy. Aims particularly at those students who have already passed their general exams, although others admitted with permission of instructor. Focuses on issues associated with designing and undertaking a substantive piece of research. Begins by examining a number of examples of successful research with a view to examining how they were designed, what research problems they confronted, and how they were surmounted. The second part reviews alternative methodologies for carrying out research. In the final part, participants’ research proposals are discussed with an eye to both their substantive and methodological dimensions.

S. Berger

17.528 Civil Society, Social Capital, and the State in Comparative Perspective
Prereq: None
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9
Examines the growing body of research suggesting that social networks, community norms, and social organizations can have important effects on social welfare, political stability, economic development, and governmental performance. Cases drawn from various countries and focus on the effects of networks, norms, and organizations on outcomes ranging from local public goods provision and the performance of democracies to ethnic conflict and funding for terrorism.

L. Tsai

17.534 Domestic Politics of Western Europe
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Compares politics and society in France, Great Britain, Germany, and Italy. Analyzes cases of the integration of feudal remnants and the problem of controlling the economy. Open to qualified undergraduates with permission from instructor.

S. Berger

17.537 Politics and Policy in Contemporary Japan
(Subject meets with 17.538)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
17.538 Politics and Policy in Contemporary Japan
(Subject meets with 17.537)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Seminar has two main goals: explores the main theoretical and methodological approaches to the study of contemporary Chinese politics; and relates those approaches to broader trends in the field of comparative politics. What has the study of China contributed to the field of comparative politics, and vice versa? What are the most effective ways to integrate area studies, broader comparative approaches, and theory? Seminar presumes a basic understanding of the history and politics of contemporary China.

E. Steinfeld

17.541 Japanese Politics and Society (Subject meets with 17.543)
Prereq: None
U (Fall)
2-0-4 [P/D/F]
Lectures, seminar discussion, small-team case studies, and web page construction exercises shed light on contemporary Japan. Focus on four substantive topics: politics and history, economy and technology, education and the workplace, and community/civil society.

R. Samuels

17.543 Japanese Politics and Society (Subject meets with 17.541)
Prereq: None
U (Fall)
2-0-7 HASS
See description under 17.541. 17.543 requires assigned additional readings, two short papers, and a final exam.

R. Samuels

17.544 Comparative Politics and China
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Seminar presumes a basic understanding of the history and politics of contemporary China.

17.547 The Rise of China (Subject meets with 17.548)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
17.548 The Rise of China (Subject meets with 17.547)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Examines the causes and consequences of China’s emergence as a global economic and political force. Employing perspectives from comparative politics and international relations, subject examines the connections between
China’s domestic transformation and its foreign policy. Topics include the historical process of China’s rise, contemporary challenges facing the Chinese system, and the impact of China’s rise on issues of regional and global concern, including military security, economic competitiveness, environmental sustainability, and political stability.

E. Steinfeld

17.554 Political Economy of Latin America
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Covers the main topics in Latin American politics over the last four decades: modernization, bureaucratic authoritarianism, civil military relations, the politics of economic reform, political transition, party systems, voting behavior, interest groups, new social movements, the mass media, political culture, and US-Latin American relations. Open to qualified undergraduates with permission of instructor.

B. Schneider

17.556 Political Economy of Sustainable Development
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Examines theoretical and empirical approaches to understanding the process of late development. Topics include the role of the state in alleviating or exacerbating poverty, the politics of industrial policy and planning, and the relationship between institutional change and growth. How over the past century have some of the world’s poorest nations achieved wealth? How have others remained mired in poverty? What are the social consequences for alternative strategies of development?

E. Steinfeld, R Locke

17.559 Comparative Security and Sustainability
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

Explores comparative approaches to security and sustainability in national and international contexts, with special emphasis on constraints, options, strategies, and policy choice. Comparisons are undertaken in terms of levels and locations (countries and regions, localities); systems (social, economic, political, and technological); methods and models (analytical, empirical, historical); time frame (past, present, and future). Levels and locations include developing and industrial contexts encompassed in a global perspective. Emphasis on specific countries and coverage shaped by students’ interest and participation. Graduate students are expected to pursue the subject in greater depth through reading and individual research.

N. Choucri

17.561 European Politics (New)
Prereq: None
U (Spring)
3-0-9 HASS

Deals with the organization of political power and the dynamics of political change in Britain, France, Germany, Italy, and Spain. Particular focus on the structure of political power within the state, and on important institutions that form the link between state and society, especially political parties and interest organizations.

K. Thelen

17.565 Israel: History, Politics, Culture, and Identity
Prereq: None
U (Spring)
3-0-9 HASS

Examines Israeli identity using a broad array of materials, including popular music, film, documentaries and art, in addition to academic historical writings. Topics include Israel’s political system and society, ethnic relations, settlement projects, and the Arab minorities in the Jewish state. Students also discuss whether there is a unique Israeli culture and the struggle for Israel’s identity.

N. Karlinsky
17.57J Soviet and Post-Soviet Politics and Society, 1917–Present
(Same subject as 21H.467J)
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 4
See description under subject 21H.467J.

E. Wood

17.582 Civil War
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Surveys the social science literature on civil war. Studies the origins of civil war, discusses variables affecting duration, and examines termination of conflict. Highly interdisciplinary and covers a wide variety of cases. Open to advanced undergraduates with permission of instructor.

R. Petersen, F. Christia

17.584 Civil-Military Relations
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Subject consists of five sections. After a general survey of the field, students consider cases of stable civilian control, military rule, and transitions from military to civilian rule. Cases are selected from around the world.

R. Petersen

17.586 Warlords, Terrorists, and Militias: Theorizing on Violent Non-State Actors
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Examines why non-state actors resort to violence, their means and tactics, and what can be done to counter that violence. Focuses on the production side of non-state violence, including the objectives and organization of insurgents, terrorists, militias and warlords, their mobilization strategies and support base, and how they coerce opponents. Also covers the response violence elicits from governments or other actors such as counterinsurgency or counterterrorism strategies.

F. Christia

17.588 Field Seminar in Comparative Politics
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Provides an introduction to the field of comparative politics. Readings include both classic and recent materials. Discusses research design and research methods, in addition to topics such as political culture, social cleavages, the state, and democratic institutions. Emphasis on each issue depends in part on the interests of the students.

C. Lawson

MODELS AND METHODS

17.800 Quantitative Research Methods I: Introduction
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Introduction to elementary statistics and its application in social sciences. Teaches students how to read and interpret the quantitative literature in various subfields of political science and public policy. Students develop elementary statistical computation skills and learn to use a statistical computing package.

J. Hainmueller

17.802 Quantitative Research Methods II: Multivariate
Prereq: 17.871 or 17.800
G (Spring)
4-0-8 H-LEVEL Grad Credit
Focus on multivariate data analysis procedures, emphasizing regression. Considers model specification, autocorrelation, instrumental variables, and causal modeling. Students must have taken at least one previous subject in statistics. Open to qualified undergraduates.

J. Hainmueller

17.804 Quantitative Research Methods III: Advanced Topics
Prereq: 17.802 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
4-0-8 H-LEVEL Grad Credit
Provides an overview of advanced topics in statistical analysis. Subjects may include systems of equations, maximum-likelihood estimation, Bayesian methods, time-series analysis, and the analysis of panel data.

J. Snyder

17.810 Game Theory and Political Theory
(Subject meets with 17.811)
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
17.811 Game Theory and Political Theory
(Subject meets with 17.810)
Prereq: None
U (Fall)
4-0-8 HASS
Introduces students to the rudiments of game theory within political science. Provides students with the ability to solve simple games. Readings draw from basic texts on game theoretic modeling and applied articles in American politics, international relations, and comparative politics. Students taking the graduate version evaluate applied theory articles in the major journals.

J. M. Snyder, Jr.

17.812J Collective Choice I
(Same subject as 14.296J)
Prereq: None
G (Fall)
4-0-8
An applied theory subject analyzing political institutions from a rational choice perspective. The chief focus is the burgeoning literature on elections, legislatures, bureaucracies, and courts. Pays some attention to institutions from a comparative perspective. Advanced undergraduates may take subject with permission of instructor.

J. M. Snyder, Jr.

17.814J Collective Choice II
(Same subject as 14.295J)
Prereq: 17.812J or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Focuses on the relationship between the behavioral models developed by formal theorists and the statistical models used in empirical estimation. The main questions are: How do researchers make the link between theory and the data? How do they generate and estimate statistical models that allow careful testing of the behavioral models? What constitutes a good test of a model? Questions studied through reading and discussion of articles that combine both empirical and theoretical analysis.

J. M. Snyder, Jr.
17.869 Political Science Scope and Methods
Prereq: None
U (Fall)
3-0-9 HASS

Introduces principles of empirical and theoretical analysis in political science through research projects currently conducted in the department. Different department faculty lead modules that introduce students to major research questions and different ways of examining those questions. Emphasizes how this research in progress relates to larger themes, and how researchers confront obstacles to inference in political science. Includes substantial instruction and practice in writing (with revision) and oral presentations. Intended primarily for majors and minors.

L. Tsai

17.871 Political Science Laboratory
Prereq: 17.869 or permission of instructor
U (Spring)
3-6-6 Institute LAB

Introduces students to the conduct of political research using quantitative methodologies. The methods are examined in the context of specific political research activities like public opinion surveys, voting behavior, Congressional behavior, comparisons of political processes in different countries, and the evaluation of public policies. Students participate in joint class projects and conduct individual projects. Does not count toward HASS Requirement.

G. Lenz

17.878 Qualitative Research: Design and Methods
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Seminar explores the development and application of qualitative research designs and methods in political analysis. Considers a broad array of approaches, from exploratory narratives to focused-comparison case studies, for investigating plausible alternative hypotheses. The focus is on analysis, not data collection.

R. Locke, E. Steinfeld

17.888 Field Research Methods
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
2-2-8 H-LEVEL Grad Credit

Introduces a variety of approaches and methods for conducting field research, including elite interviewing, participant observation, case studies, electoral analysis, cross-cultural survey research, and documentary research. Attention to conceptual, practical, and ethical issues of conducting research abroad, e.g., the role of language in social research, the limits and uses of official sources, and ethical responsibilities of social scientists. Students analyze “exemplary” publications based on field research and prepare and discuss their own research proposals.

Staff

17.891 Computational Politics
(Subject meets with 17.892)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9

17.892 Computational Politics
(Subject meets with 17.891)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9

Explores computational models of political behavior; an emerging area in political science. Connections between cognitive processes, intents, goals, and actual behaviors. Specific applications in the domains of international relations (conflict and violence) and comparative politics (internal stability and security). Students taking graduate version are expected to complete additional assignments.

N. Choucri

17.900 Foundations of Political Science
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Fundamental ideas, theories and methods in modern political science through the study of a small number of books and articles that have been influential in the field. Restricted to first-year political science PhD students.

M. Nobles

17.901 Political Science Internship and Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

17.902 Political Science Internship and Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

Independent research enabling students to do work in an agency, state, or local government, or other public organization. The academic component involves close contact between the student and a faculty advisor and written work.

C. Stewart

17.903 Community Service: Experience and Reflection
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit only if area of community service is different

Seminar involves students in the community that exists beyond the labs and classrooms of the MIT campus. Through a combination of community service and academic study, students learn about political, economic, and social issues that confront residents in Boston and Cambridge. Students volunteer in a community service agency or private organization devoted to community needs and development. Students also responsible for directed readings, short writing assignments, and six seminar sessions.

C. Stewart

GENERAL SUBJECTS

17.UR Undergraduate Research
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

17.URG Undergraduate Research
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit

Research opportunities in political science in theoretical and applied research. For further information, contact the departmental coordinator.

C. Stewart
17.907 Reading Seminar in Social Science  
Prereq: None  
U (Fall, Spring, Summer)  
Units arranged  
Can be repeated for credit  
Reading and discussion of special topics in the fields of social science. Enrollment may be limited; priority to pre-registrants.  
Staff

17.905–17.911 Reading Seminar in Social Science  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit  
Reading and discussion of special topics in the fields of social science. Open to advanced undergraduates by arrangement with individual staff members. 17.909 is taught P/D/F.  
C. Stewart

17.912, 17.914, 17.916–919 Special Topics in Political Science  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit  
17.920 Special Topics in Political Science  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit  
Reading and discussion of special topics in the field of social science.  
C. Stewart

17.921 Independent International Research Project  
(Same subject as 21F.099J)  
Prereq: Permission of instructor  
U (Fall, Spring, Summer)  
Units arranged  
Can be repeated for credit  
Independent research for students who would like to pursue a research project during their stay abroad. Initiated with faculty advisor during the term prior to leaving, students are expected to conduct research during stay abroad and complete project after return to campus. The academic component involves close contact between the student and a faculty advisor, written work, and oral presentation.  
S. Berger

17.950–17.953 Special Graduate Topic in Political Science  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit  
Open to qualified graduate students who would like to pursue special subjects or projects. Please consult graduate administration prior to registration.  
Staff

17.954–17.960 Reading Seminar in Social Science  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit  
Reading and discussion of special topics in the fields of social science. Open to advanced graduate students by arrangement with individual staff members. 17.954 and 17.959 are taught P/D/F.  
C. Stewart

17.962 Second Year Paper Workshop  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Workshop for research and writing of major research paper as part of pre-dissertation requirements. Restricted to doctoral students.  
D. Singer

17.ThG Graduate Political Science Thesis  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit  
Program of research and writing of thesis; to be arranged by the student with supervising committee.  
C. Stewart

17.ThT Thesis Research Design Seminar  
Prereq: 17.869, 17.871, or permission of instructor  
U (Fall)  
3-0-9  
Students writing a thesis in Political Science develop their research topics, review relevant research and scholarship, frame their research questions and arguments, choose an appropriate methodology for analysis, and draft the introductory and methodology sections of their theses. Includes substantial instruction and practice in writing with revision and oral presentations.  
R. Petersen

17.ThU Undergraduate Political Science Thesis  
Prereq: None  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit  
Program of research leading to the writing of an SB thesis. To be arranged by the student under approved supervision.  
C. Stewart
## Bachelor of Science in Political Science/Course 17

### General Institute Requirements (GiRs)

| Subjects          |  
|--------------------|---
| Science Requirement |  
| Humanities, Arts, and Social Sciences Requirement [three subjects can be satisfied by subjects in the Departmental Program] | 8  
| Restricted Electives in Science and Technology (REST) Requirement | 2  
| Laboratory Requirement | 1  
| **Total GIR Subjects Required for SB Degree** | 17  

### Communication Requirement

The program includes a Communication Requirement of 4 subjects:

- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

### Plus Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

**Required Subjects**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.869, Political Science Scope and Methods, 12, HASS, CI-M</td>
<td>51</td>
</tr>
<tr>
<td>17.871, Political Science Laboratory, 15, LAB, 17.869*</td>
<td></td>
</tr>
<tr>
<td>17.878, Thesis Research Design Seminar, 12, CI-M; 17.869, 17.871, or permission of instructor</td>
<td></td>
</tr>
<tr>
<td>17.879, Undergraduate Political Science Thesis (at least 12 units; additional units by special arrangement)</td>
<td></td>
</tr>
</tbody>
</table>

**Restricted Electives**

Normally seven subjects divided as follows:

- **Political philosophy/social theory**: one political science subject in the field of political philosophy/social theory (17.00–17.099)
- **American politics**: one political science subject in the field of American politics (17.20–17.299)
- **Public policy**: one political science subject in the field of public policy (17.30–17.399), or a subject in another field designated as fulfilling the public policy requirement
- **International politics**: one political science subject in the fields of international relations/security studies (17.40–17.499) or comparative politics (17.50–17.599)

*Plus* three additional political science subjects representing a coherent plan of study. Specific subjects satisfying these criteria should be chosen in consultation with a faculty advisor.

### Departmental Program Units That Also Satisfy the GIRs

(30–36)

### Unrestricted Electives

81–99

### Total Units Beyond the GIRs Required for SB Degree

180

*No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.*

### Notes

- Alternate prerequisites are listed in the subject description.
- Students typically enroll in subjects as follows: 17.869, fall term, junior year; 17.871, spring term, junior year; 17.878, fall term, senior year; 17.879, spring term, senior year.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
18.01 Calculus
Prereq: None
U (Fall, Spring)
5-0-7 CALC I
Credit cannot also be received for 18.014, 18.01A


Fall: B. B. Brubaker
Spring: Staff

18.01A Calculus
Prereq: Knowledge of differentiation and elementary integration
U (Fall)
5-0-7 CALC I
Credit cannot also be received for 18.01, 18.014

Six-week review of one-variable calculus, emphasizing material not on the high-school AB syllabus: integration techniques and applications, polar coordinates, improper integrals, infinite series. Prerequisites: one year of high-school calculus or the equivalent, with a score of 4 or 5 on the AB Calculus test (or the AB portion of the BC test, or an equivalent score on a standard international exam), or equivalent college transfer credit, or a passing grade on the first half of the 18.01 advanced standing exam.

A. P. Mattuck

18.02 Calculus
Prereq: Calculus I (GIR)
U (Fall, Spring)
5-0-7 CALC II
Credit cannot also be received for 18.022, 18.023, 18.024, 18.02A

Calculus of several variables. Vector algebra in 3-space, determinants, matrices. Vector-valued functions of one variable, space motion. Scalar functions of several variables: partial differentiation, gradient, optimization techniques. Double integrals and line integrals in the plane; exact differentials and conservative fields; Green's theorem and applications, triple integrals, line and surface integrals in space, Divergence theorem, Stokes' theorem; applications.

Fall: B. Poonen
Spring: A. P. Mattuck

18.022 Calculus
Prereq: Calculus I (GIR)
U (Fall)
5-0-7 CALC II
Credit cannot also be received for 18.02, 18.023, 18.024, 18.02A

Calculus of several variables. Topics as in 18.02 but with more focus on mathematical concepts. Vector algebra, dot product, matrices, determinant. Functions of several variables, continuity, differentiability, derivative. Parametrized curves, arc length, curvature, torsion. Vector fields, gradient, curl, divergence. Multiple integrals, change of variables, line integrals, surface integrals. Manifolds with boundary, Stokes' theorem in one, two, and three dimensions.

T. A. Kemp

18.023 Calculus with Applications
Prereq: Calculus I (GIR)
U (Fall)
5-0-7 CALC II
Credit cannot also be received for 18.02, 18.022, 18.024, 18.02A

Calculus of several variables, emphasizing applications. Vector algebra, partial differentiation, multiple integrals, and vector calculus. Asymptotic and numerical methods.

D. J. Benney

18.024 Calculus with Theory
Prereq: Calculus I (GIR) and permission of Instructor
U (Spring)
5-0-7 CALC II
Credit cannot also be received for 18.02, 18.022, 18.023, 18.02A

Continues 18.014. Parallel to 18.02, but at a deeper level, emphasizing careful reasoning and understanding of proofs. Considerable emphasis on linear algebra and vector integral calculus.

G. K. Lyo
18.03 Differential Equations
Prereq: None. Coreq: Calculus II (GIR)
U (Fall, Spring, Summer)
5-0-7 REST
Credit cannot also be received for 18.034, 18.036

Study of ordinary differential equations (ODEs), including modeling physical systems. Solution of first-order ODEs by analytical, graphical, and numerical methods. Linear ODEs, primarily second order with constant coefficients. Complex numbers and exponentials. Inhomogeneous equations: polynomial, sinusoidal, and exponential inputs. Oscillations, damping, resonance. Fourier series inputs; resonant terms. Laplace transform methods; convolution and delta function. Matrix methods for first order linear systems: eigenvalues and eigenvectors, matrix exponentials, variation of parameters. Nonlinear autonomous systems: critical point analysis, phase plane diagrams, applications to modeling.

Fall: D. A. Vogan
Spring: H. R. Miller

18.04 Complex Variables with Applications
Prereq: Calculus II (GIR); 18.03 or 18.034
U (Spring)
4-0-8
Credit cannot also be received for 18.075

Complex algebra and functions; analyticity; contour integration, Cauchy's theorem; singularities, Taylor and Laurent series; residues, evaluation of integrals; multivalued functions, potential theory in two dimensions; Fourier analysis and Laplace transforms.

H. Cheng

18.05 Introduction to Probability and Statistics
Prereq: Calculus I (GIR)
U (Spring)
3-0-9 REST
Credit cannot also be received for 6.041


L. Wang

18.06 Linear Algebra
Prereq: Calculus II (GIR)
U (Fall, Spring, Summer)
4-0-8 REST
Credit cannot also be received for 18.700

Basic subject on matrix theory and linear algebra, emphasizing topics useful in other disciplines, including systems of equations, vector spaces, determinants, eigenvalues, singular value decomposition, and positive definite matrices. Applications to least-squares approximations, stability of differential equations, networks, Fourier transforms, and Markov processes. Uses MATLAB. Compared with 18.700, more emphasis on matrix algorithms and many applications.

Fall: A. Postnikov
Spring: G. Strang

18.062J Mathematics for Computer Science
(Same subject as 6.042J)
Prereq: Calculus I (GIR)
U (Fall, Spring)
5-0-7 REST

See description under subject 6.042J.

A. R. Meyer, T. Leighton

18.075 Advanced Calculus for Engineers
Prereq: Calculus II (GIR); 18.03
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit

Functions of a complex variable; calculus of residues. Ordinary differential equations; Bessel and Legendre functions; Sturm-Liouville theory; partial differential equations.

Fall: H. Cheng
Spring: T. Gilet

18.085 Computational Science and Engineering I
Prereq: Calculus II (GIR); 18.03 or 18.034
G (Fall, Spring, Summer)
3-0-9 H-LEVEL Grad Credit

Review of linear algebra, applications to networks, structures, and estimation, finite difference and finite element solution of differential equations, Laplace's equation and potential flow, boundary-value problems, Fourier series, discrete Fourier transform, convolution. Frequent use of MATLAB in a wide range of scientific and engineering applications.

Fall: G. Strang
Spring: L. Demanet

18.086 Computational Science and Engineering II
Prereq: Calculus II (GIR); 18.03 or 18.034
G (Spring)
3-0-9 H-LEVEL Grad Credit


Information: G. Strang

18.089 Review of Mathematics
Prereq: Permission of instructor
G (Summer)
Units arranged

One-week review of one-variable calculus (18.01), followed by concentrated study covering multivariable calculus (18.02), two hours per day for five weeks. Primarily for graduate students in Course 2N. Degree credit allowed only in special circumstances.

Information: A. P. Mattuck
18.094|Teaching College-Level Science and Engineering
(Same subject as 5.95j, 6.982j, 7.59j, 8.395j).
Prerequisite: None
G (Spring)
2-0-2 [P/D/F]
See description under subject 5.95j.
L. Breslow

18.095 Mathematics Lecture Series
Prerequisite: Calculus I (GIR)
U (IAP)
2-0-4 [P/D/F]
Can be repeated for credit
The ten lectures by mathematics faculty members on interesting topics from both classical and modern mathematics. All lectures accessible to students with calculus background and an interest in mathematics. At each lecture, reading and exercises are assigned. Students prepare these for discussion in a weekly problem session.
Information: H. R. Miller

18.098 Independent Activities
Prerequisite: Permission of instructor
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit
Studies or special individual reading arranged in consultation with individual faculty members and subject to departmental approval.
Information: H. R. Miller

18.099 Independent Activities
Prerequisite: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Studies (during IAP) or special individual reading (during regular terms). Arranged in consultation with individual faculty members and subject to departmental approval.
Information: H. R. Miller

ANALYSIS

18.100A Analysis I
Prerequisite: Calculus II (GIR); 18.03 or 18.034
U (Fall, Spring)
3-0-9 H-LEVEL Grad Credit (except for Course 18 students)
Credit cannot also be received for 18.100B, 18.100C

18.100B Analysis I
Prerequisite: Calculus II (GIR); 18.03 or 18.034
U (Fall, Spring)
3-0-9 H-LEVEL Grad Credit (except for Course 18 students)
Credit cannot also be received for 18.100A, 18.100C

18.100C Analysis I
Prerequisite: Calculus II (GIR); 18.03 or 18.034
U (Fall, Spring)
4-0-11
Credit cannot also be received for 18.100A, 18.100B

Three options offered, each covering fundamentals of mathematical analysis: convergence of sequences and series, continuity, differentiability, Riemann integral, sequences and series of functions, uniformity, interchange of limit operations. Each option shows the utility of abstract concepts and teaches understanding and construction of proofs. Option A: Proofs and definitions are less abstract. Gives applications where possible. Concerned primarily with the real line. Option B: More demanding; for students with more mathematical maturity. Places more emphasis on point-set topology and n-space. Option C: 15-unit (4-0-11) variant of Option B, with further instruction and practice in written and oral communication. Enrollment limited.

18.100A: Consult A. P. Mattuck
18.100B: Consult R. B. Melrose
18.100C: Consult H. R. Miller

18.101 Analysis II
Prerequisite: 18.100; 18.06, 18.700, or 18.701
U (Fall)
3-0-9 H-LEVEL Grad Credit (except for Course 18 students)
Introduction to the theory of manifolds: vector fields and densities on manifolds, integral calculus in the manifold setting and the manifold version of the divergence theorem. 18.901 helpful but not required.

V. W. Guillemin

18.102 Introduction to Functional Analysis
Prerequisite: 18.100; 18.06, 18.700, or 18.701
U (Spring)
3-0-9 H-LEVEL Grad Credit (except for Course 18 students)

R. B. Melrose

18.103 Fourier Analysis-Theory and Applications
Prerequisite: 18.100; 18.06, 18.700, or 18.701
U (Fall)
3-0-9 H-LEVEL Grad Credit (except for Course 18 students)
Roughly half the subject devoted to the theory of the Lebesgue integral with applications to probability, and half to Fourier series and Fourier integrals.

J. Kim

18.104 Seminar in Analysis
Prerequisite: 18.100
U (Fall)
3-0-9
Seminar for Mathematics majors. Students present and discuss subject matter taken from current journals or books. Topics vary from year to year. Topics for fall 2009: A problem-solving based introduction to topics in real and complex analysis and related combinatorics and probability, based on Polya and Szego’s “Problems and Theorems in Analysis.” Instruction and practice in written and oral communication provided. Enrollment limited.

T. S. Mrowka

18.112 Functions of a Complex Variable
Prerequisite: 18.100; 18.06, 18.700, or 18.701
U (Fall)
3-0-9
H-LEVEL Grad Credit (except for Course 18 students)

V. G. Kac
18.116 Riemann Surfaces
Prereq: 18.112
G (Fall)
3-0-9 H-LEVEL Grad Credit
Riemann surfaces, uniformization, Riemann-Roch Theorem. Theory of elliptic functions and modular forms. Some applications, such as to number theory.
T. S. Mrowka

18.117 Topics in Several Complex Variables
Prereq: 18.112, 18.965
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Harmonic theory on complex manifolds, Hodge decomposition theorem, Hard Lefschetz theorem. Vanishing theorems. Theory of Stein manifolds. As time permits students also study holomorphic vector bundles on Kähler manifolds.
Information: R. B. Melrose

18.125 Real and Functional Analysis
Prereq: 18.100
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introductions to set theory and general topology as needed in analysis. Lebesgue’s integration theory. Introduction to functional analysis, Banach and Hilbert spaces.
H. P. Christianson

18.135 Geometric Analysis
Prereq: 18.745 or 18.755
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
A quick description of Riemannian symmetric spaces. Spherical functions and Harish-Chandra’s f-function. Fourier transforms and Radon transforms on Riemannian symmetric spaces X. Applications to invariant differential equations, in particular the multitemporal wave equation on X. Eigenspace representations.
Information: S. Helgason

18.137 Topics in Geometric Partial Differential Equations (New)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
T. H. Colding

18.152 Introduction to Partial Differential Equations
Prereq: 18.100; 18.06, 18.700, or 18.701
U (Fall)
3-0-9 H-LEVEL Grad Credit (except for Course 18 students)
Initial and boundary value problems for the wave and heat equation, including an introduction to Fourier analysis and tempered distributions. Laplace’s equation, Dirichlet problem, and potential theory. Method of characteristics for first-order partial differential equations. Schrödinger’s equation and eigenfunction expansions. Introductory examples of nonlinear partial differential equations.
B. L. Kotschwar

18.155 Differential Analysis
Prereq: 18.102 or 18.103
G (Fall)
3-0-9 H-LEVEL Grad Credit
18.156 Differential Analysis
Prereq: 18.155
G (Spring)
3-0-9 H-LEVEL Grad Credit
Fall: S. Helgason
Spring: Information—R. B. Melrose

18.157 Introduction to Microlocal Analysis
Prereq: 18.155
G (Fall)
3-0-9 H-LEVEL Grad Credit
The semi-classical theory of partial differential equations. Discussion of Pseudodifferential operators, Fourier integral operators, asymptotic solutions of partial differential equations, and the spectral theory of Schrödinger operators from the semi-classical perspective. Heavy emphasis placed on the symplectic geometric underpinnings of this subject.
R. B. Melrose

18.158 Topics in Differential Equations
Prereq: 18.157
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Content varies from year to year.
Information: R. B. Melrose

18.175 Theory of Probability
Prereq: 18.125
G (Spring)
3-0-9 H-LEVEL Grad Credit
Sums of random independent random variables, central limit phenomena, infinitely divisible laws, Levy processes, Brownian motion, conditioning, and martingales.
D. W. Stroock

18.177 Topics in Stochastic Processes
Prereq: 18.175
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year. Spring 2010: Begins with a review of Gaussian measures in infinite dimensions, with emphasis on L. Gross’s theory of abstract Wiener spaces. Initial segment ends with large deviations estimates for rescaled Wiener measure and their application to Strassen’s law of the iterated logarithm for Gaussian measures on a Banach space. Second part focuses on other aspects of the theory of large deviations, including work by Donsker and Varadhan on the large deviations of empirical measures for ergodic Markov processes. At least one term of graduate level probability theory and analysis required.
D. W. Stroock

18.199 Graduate Analysis Seminar
Prereq: Permission of instructor
G (Spring)
3-0-21 H-LEVEL Grad Credit
Can be repeated for credit
Studies original papers in differential analysis and differential equations. Intended for first- and second-year graduate students. Permission must be secured in advance.
Information: R. B. Melrose
18.238 Geometry and Quantum Field Theory
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

A rigorous introduction designed for mathematicians into perturbative quantum field theory, using the language of functional integrals. Basics of classical field theory. Free quantum theories. Feynman diagrams. Renormalization theory. Local operators. Operator product expansion. Renormalization group equation. The goal is to discuss, using mathematical language, a number of basic notions and results of QFT that are necessary to understand talks and papers in QFT and string theory.

Information: P. I. Etingof

18.276 Mathematical Methods in Physics
Prereq: 18.745 or some familiarity with Lie theory
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Content varies from year to year. Recent developments in quantum field theory require mathematical techniques not usually covered in standard graduate subjects.

V. W. Guillemin

APPLIED MATHEMATICS

18.303 Linear Partial Differential Equations
Prereq: Calculus II (GIR); 18.03 or 18.034
U (Fall)
3-0-9

The classical partial differential equations of applied mathematics: diffusion, Laplace/Poisson, and wave equations. Methods of solution, such as separation of variables, Fourier series and transforms, eigenvalue problems. Green's function methods are emphasized. 18.04 or 1112 are useful, as well as previous acquaintance with the equations as they arise in scientific applications.

D. Z. Freedman

18.304 Undergraduate Seminar in Discrete Mathematics
Prereq: 18.310 or 18.310C; 18.06, 18.700, or 18.701; or permission of instructor
U (Spring)
3-0-9

Credit cannot also be received for 18.316

Seminar in combinatorics, graph theory, and discrete mathematics in general. Participants read and present papers from recent mathematics literature. Instruction and practice in written and oral communication provided. Enrollment limited.

D. J. Kleitman

18.305 Advanced Analytic Methods in Science and Engineering
Prereq: 18.04, 18.075, or 18.112
G (Fall)
3-0-9 H-LEVEL Grad Credit

A comprehensive treatment of the advanced methods of applied mathematics. Designed to strengthen the mathematical abilities of graduate students and train them to think on their own. Expansion around singular points: special functions; the WKB method on ordinary and partial differential equations; the method of stationary phase and the saddle point method; the two-scale method and the method of renormalized perturbation; singular perturbation and boundary-layer techniques.

H. Cheng

18.306 Advanced Partial Differential Equations with Applications
Prereq: 18.03 or 18.034; 18.04, 18.075, or 18.112
G (Fall)
3-0-9 H-LEVEL Grad Credit


R. R. Rosales

18.307 Integral Equations
Prereq: 18.04, 18.075, or 18.112
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Emphasis on concepts and techniques for solving integral equations from an applied mathematics perspective. Selection of material from the following topics: Volterra and Fredholm equations, Fredholm theory, the Hilbert-Schmidt theorem; Wiener-Hopf Method; Wiener-Hopf Method and partial differential equations; the Hilbert Problem and singular integral equations of Cauchy type; inverse scattering transform; group theory. Examples from fluid and solid mechanics, acoustics, quantum mechanics, and other applications.

Information: R. R. Rosales

18.308 Wave Motion
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Dispersive and non-dispersive waves in fluids, with emphasis on nonlinear effects and applications to geophysical flows and nonlinear acoustics. Stability of shear and stratified flows; surface and internal waves; nonlinear resonant interactions; solitons and solitary wave interactions; characteristics, nonlinear breaking, hydraulic jumps, and bores; weakly nonlinear theory; dispersive wave turbulence; weakly nonlinear geometrical optics and modulation; wave boundary layer phenomena.

Information: D. J. Benney

18.310 Principles of Applied Mathematics
Prereq: Calculus II (GIR)
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9

Credit cannot also be received for 18.310C

Study of illustrative topics in discrete applied mathematics including sorting algorithms, information theory, coding theory, secret codes, generating functions, linear programming, probability theory, and game theory.

Information: P. W. Shor

18.310C Principles of Applied Mathematics
Prereq: Calculus II (GIR)
U (Spring)
3-0-9

Credit cannot also be received for 18.310

Study of illustrative topics in discrete applied mathematics, including sorting algorithms, information theory, coding theory, secret codes, generating functions, linear programming, probability theory, and game theory. Instruction and practice in written communication provided. Same content as 18.310, but assignments are structured with an additional focus on writing. Enrollment limited.

P. W. Shor, M. X. Goemans

18.311 Principles of Applied Mathematics
Prereq: Calculus II (GIR); 18.03 or 18.034
U (Spring)
3-0-9

Introduction to fundamental concepts in continuous applied mathematics. Continuum limit and

R. R. Rosales

18.312 Algebraic Combinatorics
Prereq: 18.701 or 18.703
U (Spring)
3-0-9
Applications of algebra to combinatorics. Topics include walks in graphs, the Radon transform, groups acting on posets, Young tableaux, electrical networks.
R. P. Stanley

18.314 Combinatorial Analysis
Prereq: Calculus II (GIR); 18.06, 18.700, or 18.701
U (Fall)
3-0-9
Combinatorial problems and methods for their solution. Enumeration, generating functions, recurrence relations, construction of bijections. Introduction to graph theory. Prior experience with abstraction and proofs is helpful.
S. H. Assaf

18.315 Combinatorial Theory
Prereq: Permission of instructor
G (Fall)
3-0-9
H-LEVEL Grad Credit
Can be repeated for credit
Content varies from year to year. Fall 2009: Generating functions.
R. P. Stanley

18.316 Seminar in Combinatorics
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9
H-LEVEL Grad Credit
Can be repeated for credit
Credit cannot also be received for 18.304
Content varies from year to year. Readings from current research papers in combinatorics. Topics to be chosen and presented by the class.
Information: D. J. Kleitman

18.318 Topics in Combinatorics
Prereq: Permission of instructor
G (Spring)
3-0-9
H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year.
A. Postnikov

18.319 Combinatorics and Geometry
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9
H-LEVEL Grad Credit
Connections between combinatorics and geometry (and algebra). Discussion of combinatorial problems that arise in algebraic geometry, convex geometry, and algebraic topology. Topics include toric varieties, polytopes and fans, hyperplane arrangements, triangulations and tilings, matroids, topological combinatorics, Schubert calculus.
Information: A. Postnikov

18.325 Topics in Applied Mathematics
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9
H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year.
Fall: L. Demanet
Spring: Information—M. X. Goemans

18.330 Introduction to Numerical Analysis
Prereq: Calculus II (GIR); 18.03 or 18.034
U (Spring)
3-0-9
D. S.-W. Tam

18.335J Introduction to Numerical Methods
(Same subject as 6.337J)
Prereq: 18.03 or 18.034; 18.06, 18.700, or 18.701
G (Fall)
3-0-9
H-LEVEL Grad Credit
Advanced introduction to numerical linear algebra and related numerical methods. Topics include direct and iterative methods for linear systems, eigenvalue decompositions and QR/SVD factorizations, stability and accuracy of numerical algorithms, the IEEE floating point standard, sparse and structured matrices, preconditioning, linear algebra software. Problem sets require some knowledge of MATLAB. S. G. Johnson

18.336 Numerical Methods for Partial Differential Equations
Prereq: 18.330, 18.335J,
G (Spring)
3-0-9
H-LEVEL Grad Credit
Advanced introduction to applications and theory of numerical methods for solution of differential equations, especially of physically-arising partial differential equations, with emphasis on the fundamental ideas underlying various methods. Topics include finite differences, spectral methods, finite elements, well-posedness and stability, particle methods and lattice gases, boundary and nonlinear instabilities.
A. Edelman

18.337J Parallel Computing
(Same subject as 6.338J)
Prereq: 18.06, 18.700, or 18.701
G (Spring)
3-0-9
H-LEVEL Grad Credit
Advanced interdisciplinary introduction to modern scientific computing on parallel supercomputers. Numerical topics include dense and sparse linear algebra, N-body problems, and Fourier transforms. Geometrical topics include partitioning and mesh generation. Other topics include architectures and software systems with emphasis on understanding the realities and myths of what is possible on the world’s fastest machines. Programming languages include MPI and Star-P with MATLAB and Python.
A. Edelman

18.338 Eigenvalues of Random Matrices
Prereq: Permission of instructor
G (Fall)
3-0-9
H-LEVEL Grad Credit
An introduction to the theory and applications of stochastic eigen-analysis. Theoretical topics include matrix calculus, “free” probability, and stochastic operators. Applications in signal processing, finance, and large stochastic systems are discussed. There is a hands-on emphasis on using the theory to discover new applications.
A. Edelman
18.353J Nonlinear Dynamics I: Chaos
(Same subject as 2.050J, 12.006J)
Prereq: 18.03 or 18.034; Physics II (GIR)
U (Fall)
3-0-9
See description under subject 12.006J.
T. Peacock

18.354J Nonlinear Dynamics II: Continuum Systems
(Same subject as 12.207J)
Prereq: 18.353J/12.006J or permission of instructor
U (Spring)
3-0-9 H-LEVEL Grad Credit (except for Course 18 students)

General mathematical principles of continuum systems. (1) From microscopic to macroscopic. Examples range from random walkers, to Newtonian mechanics, to option pricing. (2) Singular Perturbations. Examples include boundary layer theory, snow flakes and geophysical flows. (3) Instability. Generalize ideas from 18.353 to continuum systems. Examples from fluid mechanics, solid mechanics, astrophysics and biology. (4) Pattern formation and turbulence.
P. M. Reis

18.355 Fluid Mechanics
Prereq: 18.354J, 12.800, 2.25, or 16.121
G (Fall)
3-0-9 H-LEVEL Grad Credit

Topics include the development of Navier-Stokes equations, ideal flows, boundary layers, lubrication theory, Stokes flows, and surface tension. Fundamental concepts illustrated through problems drawn from a variety of areas including geophysics, bilocomotion and the dynamics of sport. Particular emphasis is given to the interplay between dimensional analysis, scaling arguments and rigorous theory. Course material supplemented by classroom and laboratory demonstrations.
J. W. Bush

18.366 Random Walks and Diffusion
Prereq: 18.305 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Mathematical modeling of diffusion phenomena: Central limit theorems, the continuum limit, Fokker-Planck equation, first passage, persistence and self avoidance, continuous-time random walks, Levy flights, random environments, advection-diffusion, diffusion-limited aggregation. Applications include polymers, turbulence, fractal growth, granular flow, and financial derivatives.
Information: M. X. Goemans

18.369 Mathematical Methods in Nanophotonics
Prereq: 18.305 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

High-level approaches to understanding complex optical media, structured on the scale of the wavelength, that are not generally analytically solvable. The basis for understanding optical phenomena such as photonic crystals and band gaps, anomalous diffraction, mechanisms for optical confinement, optical fibers (new and old), nonlinearities, and integrated optical devices. Methods covered include linear algebra and eigensystems for Maxwell’s equations, symmetry groups and representation theory, Bloch’s theorem, numerical eigensolver methods, time and frequency-domain computation, perturbation theory, and coupled-mode theories.
S. G. Johnson

18.376J Wave Propagation
(Same subject as 1.138J, 2.062J)
Prereq: 2.003J, 18.075
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 2.062J.
T. R. Akylas, R. R. Rosales

18.377J Nonlinear Dynamics and Waves
(Same subject as 1.685J, 2.034J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

A unified treatment of nonlinear oscillations and wave phenomena with applications to mechanical, optical, geophysical, fluid, electrical and flow-structure interaction problems. Nonlinear free and forced vibrations; nonlinear resonances; self-excited oscillations; lock-in phenomena. Nonlinear dispersive and nondispersive waves; resonant wave interactions; propagation of wave pulses and nonlinear Schrodinger equation. Nonlinear long waves and breaking; theory of characteristics; the Korteweg-de Vries equation; solitons and solitary wave interactions. Stability of shear flows. Some topics and applications may vary from year to year.
T. R. Akylas, R. R. Rosales

18.384 Undergraduate Seminar in Physical Mathematics
Prereq: 18.311, 18.354, or permission of instructor
U (Fall)
3-0-9
The applied mathematics of continuous media and classical physics. Reading and presentation of papers from recent applied mathematics and physics literature. Topics and papers include fluid mechanics, solid mechanics, and biophysics. Instruction and practice in written and oral communication provided. Enrollment limited.
P. M. Reis

18.385J Nonlinear Dynamics and Chaos
(Same subject as 2.036J)
Prereq: 18.03 or 18.034
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Introduction to the modern theory of nonlinear dynamical systems with an emphasis on applications in science and engineering. Local and global existence of solutions to nonlinear dynamical systems, their dependence on initial data and parameters. Phase plane, limit cycles, Poincare-Bendixson theory, Time-dependent systems, Floquet theory, Poincare maps, averaging. Stability of equilibria, near-equilibrium dynamics. Center manifolds, elementary bifurcations, normal forms. Introduction to chaos. Physical applications.
Information: R. R. Rosales

18.386J Advanced Nonlinear Dynamics and Chaos
(Same subject as 2.037J)
Prereq: 18.385/2.036 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Information: R. R. Rosales
THEORETICAL COMPUTER SCIENCE

18.400J Automata, Computability, and Complexity
(Same subject as 6.045J)
Prereq: 6.042J
U (Spring)
4-0-8
See description under subject 6.045J.
S. Micali

18.404J Theory of Computation
(Same subject as 6.840J)
Prereq: 18.310 or 18.062J
G (Fall)
4-0-8
H-LEVEL Grad Credit (except for Course 18 students)
A more extensive and theoretical treatment of the material in 6.045/18.400J, emphasizing computability and computational complexity theory. Regular and context-free languages. Decidable and undecidable problems, reducibility, recursive function theory. Time and space measures on computation, completeness, hierarchy theorems, inherently complex problems, oracles, probabilistic computation, and interactive proof systems.
M. Sipser

18.405J Advanced Complexity Theory
(Same subject as 6.841J)
Prereq: 6.840J/18.404J
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Information: M. Sudan, M. Sipser

18.410J Design and Analysis of Algorithms
(Same subject as 6.046J)
Prereq: 6.006 (alternatively: 6.001; 6.042/18.062 or 18.310)
U (Fall)
4-0-8
See description under subject 6.046J.
C. E. Leiserson, M. Goemans

18.415J Advanced Algorithms
(Same subject as 6.854J)
Prereq: 6.041, 6.042J, or 18.440; 6.046J
G (Fall)
5-0-7 H-LEVEL Grad Credit
See description under subject 6.854J.
D. R. Karger

18.416J Randomized Algorithms
(Same subject as 6.856J)
Prereq: 6.854J, 6.041 or 6.042J
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
5-0-7 H-LEVEL Grad Credit
See description under subject 6.856J.
D. R. Karger

18.417 Introduction to Computational Molecular Biology
Prereq: 6.001, 6.006, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduces the basic computational methods used to model and predict the structure of biomolecules (proteins, DNA, RNA). Covers classical techniques in the field (molecular dynamics, Monte Carlo, dynamic programming) to more recent advances in analyzing and predicting RNA and protein structure, ranging from Hidden Markov Models and 3-D lattice models to attribute Grammars and tree Grammars.
J. Waldspühl

18.418 Topics in Computational Molecular Biology
Prereq: 18.417, 6.047, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Covers current research topics in computational molecular biology. Recent research papers presented from leading conferences such as the SIGACT International Conference on Computational Molecular Biology (RECOMB). Topics include original research (both theoretical and experimental) in comparative genomics, sequence
and structure analysis, molecular evolution, proteomics, gene expression, transcriptional regulation, and biological networks. Recent research by course participants also covered. Participants will be expected to present either group or individual projects to the class.

B. Berger

18.424 Seminar in Information Theory
Prereq: 18.05, 18.440, or 6.041; 18.06, 18.700, or 18.701
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9

Considers various topics in information theory, including data compression, Shannon's Theorems, and error-correcting codes. Students present and discuss the subject matter. Instruction and practice in written and oral communication provided. Enrollment limited.

Information: P. W. Shor

18.425 J Cryptography and Cryptanalysis
(Same subject as 6.875 J)
Prereq: 6.046 J
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.875 J.
S. Goldwasser, S. Micali

18.426 J Advanced Topics in Cryptography
(Same subject as 6.876 J)
Prereq: 6.875 J/18.425 J
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

See description under subject 6.876 J.
S. Goldwasser, S. Micali

18.433 Combinatorial Optimization
Prereq: 18.06, 18.700, or 18.701
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 H-LEVEL Grad Credit (except for Course 18 students)

Thorough treatment of linear programming and combinatorial optimization. Topics include matching theory, network flow, matroid optimization, and how to deal with NP-hard optimization problems. Prior exposure to discrete mathematics (such as 18.310) helpful.

Information: M. X. Goemans

18.434 Seminar in Theoretical Computer Science
Prereq: 18.404, 18.410
U (Spring)
3-0-9

Topics vary from year to year. Students present and discuss the subject matter. Instruction and practice in written and oral communication provided. Enrollment limited.

M. X. Goemans

18.435 J Quantum Computation
(Same subject as 2.111 J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Provides an introduction to the theory and practice of quantum computation. Topics covered: physics of information processing; quantum algorithms including the factoring algorithm and Grover’s search algorithm; quantum error correction; quantum communication and cryptography. Knowledge of quantum mechanics helpful but not required.

E. Farhi, S. Lloyd, P. Shor

18.436 J Quantum Information Science
(Same subject as 6.443 J, 8.371 J)
Prereq: 18.435
G (Spring)
3-0-9 H-LEVEL Grad Credit

Subject examines quantum computation and quantum information. Topics include quantum circuits, quantum Fourier transform and search algorithms, physical implementations, the quantum operations formalism, quantum error correction, stabilizer and Calderbank-Shor-Steans codes, fault tolerant quantum computation, quantum data compression, entanglement, capacity of quantum channels, and proof of the security of quantum cryptography. Prior knowledge of quantum mechanics is required.

P. Shor

18.437 J Distributed Algorithms
(Same subject as 6.852 J)
Prereq: 6.046 J
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

See description under subject 6.852 J.
N. A. Lynch

18.438 Advanced Combinatorial Optimization (New)
Prereq: 18.433 or permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Advanced treatment of combinatorial optimization with an emphasis on combinatorial aspects. Non-bipartite matchings, submodular functions, matroid intersection/union, matroid matching, submodular flows, multicommodity flows, packing and connectivity problems, and other recent developments.

M. X. Goemans

PROBABILITY AND STATISTICS

18.440 Probability and Random Variables
Prereq: Calculus II (GIR)
U (Fall, Spring)
3-0-9


Fall: S. Sheffield
Spring: J. A. Kelner

18.443 Statistics for Applications
Prereq: 18.440 or 6.041
U (Fall, Spring)
3-0-9 H-LEVEL Grad Credit (except for Course 18 students)

A broad treatment of statistics, concentrating on specific statistical techniques used in science and industry. Topics: hypothesis testing and estimation. Confidence intervals, chi-square tests, nonparametric statistics, analysis of variance, regression, correlation, decision theory, and Bayesian statistics.

Fall: L. Wang
Spring: R. M. Dudley

18.445 Introduction to Stochastic Processes
Prereq: 18.440 or 6.041
G (Spring)
3-0-9 H-LEVEL Grad Credit


R. M. Dudley
18.447 Probabilistic Methods in Combinatorics and Algorithms
Prereq: 18.310 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Probabilistic methods are used extensively in combinatorics and in the study of algorithms in computer science. This course develops some of the basic tools and illustrates their use via examples. Topics include the probabilistic method of Erdős and the theory of random graphs.
Information: P. W. Shor

18.465 Topics in Statistics
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from term to term. Fall 2009: Non-parametrics and computing.
R. M. Dudley

18.466 Mathematical Statistics
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Decision theory, estimation, confidence intervals, hypothesis testing. Introduces large sample theory. Asymptotic efficiency of estimates. Exponential families. Sequential analysis.
L. Wang

Civil and Environmental Engineering: 1.151, 1.155, 1.202j, 1.203j, and 1.205j
Electrical Engineering and Computer Science:
6.041, 6.231, 6.245, 6.262, 6.431, and 6.435
Management: 15.034, 15.070, 15.075, and 15.098
Mathematics: 18.05, 18.175, 18.177, 18.440, 18.443, 18.445, and 18.465
See also: 2.830, 5.70, 5.72, 7.02, 8.044, 8.08, 10.816, 11.220, 11.221, 16.322, 22.38, HST.191, and MAS.622j

LOGIC

18.504 Seminar in Logic
Prereq: 18.100; 18.06, 18.510, 18.511, 18.700, or 18.701
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9

Students present and discuss the subject matter taken from current journals or books. Topics vary from year to year. Instruction and practice in written and oral communication provided. Enrollment limited.
Information: B. Poonen

18.510 Introduction to Mathematical Logic and Set Theory
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9

Information: B. Poonen

18.511 Introduction to Computability and Undecidability
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9

Church’s thesis and models of computation. Elementary computability theory: enumeration and recursion theorems, the halting problem, relative computability, Turing degrees, and basic priority constructions. Post’s problem. Truth vs. provability, Gödel’s incompleteness theorem. Decidable and undecidable problems in number theory and other areas of mathematics.
M. Minnes

18.515 Mathematical Logic
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

C. Freer

18.565 Recursion Theory
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Topics in recursion theory chosen from priority arguments, hyperarithmetic theory, ordinal recursion, E-recursion, theory of projective sets. A previous subject in logic recommended but not required.
Information: B. Poonen

18.575 Model Theory
Prereq: 18.510, 18.511, or 18.515
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Compactness theorem, ultraproducts, quantifier elimination, model completeness, Lowenheim-Skolem theorem, omitting types theorem, atomic and prime models, saturated and homogeneous models, indiscernibles, countable models, Morley’s theorem, Baldwin-Lachlan theorem, omega-stability, forking and independence, model theory of algebraically closed and real closed fields, applications to algebra.
Information: B. Poonen

18.585 Set Theory
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Topics in set theory chosen from large cardinals, combinatorial set theory, forcing, descriptive set theory, fine structure theory.
Information: B. Poonen

ALGEBRA AND NUMBER THEORY

18.700 Linear Algebra
Prereq: Calculus II (GIR)
U (Fall)
3-0-9 REST
Credit cannot also be received for 18.06

Vector spaces, systems of linear equations, bases, linear independence, matrices, determinants, eigenvalues, inner products, quadratic forms, and canonical forms of matrices. More emphasis on theory and proofs than in 18.06.
T. A. Putman
18.701 Algebra I
Prereq: 18.700, 18.100, or permission of instructor
U (Fall) 3-0-9

18.702 Algebra II
Prereq: 18.701
U (Spring) 3-0-9

More extensive and theoretical than the 18.700–18.703 sequence. Experience with proofs necessary. First term: group theory, geometry, and linear algebra. Second term: group representations, rings, ideals, fields, polynomial rings, modules, factorization, integers in quadratic number fields, field extensions, Galois theory.

M. Artin

18.703 Modern Algebra
Prereq: Calculus II (GIR) 3-0-9

Focuses on traditional algebra topics that have found greatest application in science and engineering as well as in mathematics: group theory, emphasizing finite groups; ring theory, including ideals and unique factorization in polynomial and Euclidean rings; field theory, including properties and applications of finite fields. 18.700 and 18.703 together form a standard algebra sequence.

V. G. Kac

18.704 Seminar in Algebra
Prereq: 18.06, 18.700, or 18.701 U (Fall, Spring) 3-0-9

Topics vary from year to year. Students present and discuss the subject matter. Instruction and practice in written and oral communication provided. Some experience with proofs required. Topic for fall 2009: Representation theory of finite groups. Topic for spring 2010: Computational algebra and algebraic geometry. Enrollment limited.

Fall: G. Lusztig
Spring: S. Kleiman

18.705 Commutative Algebra
Prereq: 18.702 or 18.703 3-0-9

G (Fall) 3-0-9 H-LEVEL Grad Credit

Noetherian rings and modules, Hilbert basis theorem, Cayley-Hamilton theorem, integral dependence, Noether normalization, the Nullstellensatz, localization, primary decomposition, DVRs, filtrations, length, Artin rings, Hilbert polynomials, tensor products, and dimension theory.

S. Kleiman

18.706 Noncommutative Algebra
Prereq: 18.705 3-0-9

G (Spring) 3-0-9 H-LEVEL Grad Credit

Wedderburn theory, Morita equivalence, localization and Goldie’s theorem, central simple algebras and the Brauer group, maximal orders, representations, polynomial identity rings, invariant theory growth of algebras, Gelfand-Kirillov dimension.

R. Bezrukavnikov

18.712 Introduction to Representation Theory
Prereq: 18.702 or 18.703 3-0-9

Acad Year 2009–2010: Not offered Acad Year 2010–2011: U (Fall) 3-0-9


Information: D. A. Vogan

18.721 Introduction to Algebraic Geometry (New)
Prereq: 18.702, 18.901 3-0-9

U (Fall) 3-0-9

Introduction to affine and projective algebraic geometry. Emphasis on basic examples of complex algebraic varieties, including algebraic curves.

M. Artin

18.725 Algebraic Geometry
Prereq: 18.705 3-0-9

G (Fall) 3-0-9 H-LEVEL Grad Credit

18.726 Algebraic Geometry
Prereq: 18.725 3-0-9

G (Spring) 3-0-9 H-LEVEL Grad Credit

Introduces the basic notions and techniques of modern algebraic geometry. 18.725: Fundamental notions and results about algebraic varieties over an algebraically closed field; relations between complex algebraic varieties and complex analytic varieties; examples with emphasis on algebraic curves and surfaces. May be taken concurrently with 18.705. Knowledge of elementary algebraic topology, elementary differential geometry recommended, but not required. 18.726: Introduction to the language of schemes, properties of morphisms, and sheaf cohomology.

J. McKernan

18.727 Topics in Algebraic Geometry
Prereq: 18.725 3-0-9

G (Fall) 3-0-9 H-LEVEL Grad Credit

Can be repeated for credit

Topics vary from year to year. Topic for fall 2009: Algebraic cycles on abelian varieties.

J. Suh

18.735 Topics in Algebra
Prereq: Permission of instructor 3-0-9

G (Fall) 3-0-9 H-LEVEL Grad Credit

Can be repeated for credit

Topics vary from year to year. Fall 2009: Double affine Hecke algebras (DAHA). DAHA—also called Cherednik algebras—and their representations appear in many contexts: integrable systems (Calogero-Moser and Ruijsenaars models), algebraic geometry (Hilbert schemes), orthogonal polynomials, Lie theory, quantum groups, etc. Review of the basic theory of DAHA and their representations, emphasizing their connections with other subjects and open problems.

P. I. Etingof

18.737 Algebraic Groups
Prereq: 18.705 3-0-9

Acad Year 2009–2010: Not offered Acad Year 2010–2011: G (Fall) 3-0-9 H-LEVEL Grad Credit

Structure of linear algebraic groups over an algebraically closed field, with emphasis on reductive groups. Representations of groups over a finite field using methods from etale cohomology. Some results from algebraic geometry are stated without proof.

Information: G. Lusztig

18.739 Theory of Invariants (New)
Prereq: 18.705 3-0-9

G (Fall) 3-0-9 H-LEVEL Grad Credit

18.745 Introduction to Lie Algebras
Prereq: 18.701 or 18.703
G (Fall)
3-0-9 H-LEVEL Grad Credit
G. Lusztig

18.747 Infinite-dimensional Lie Algebras
Prereq: 18.745
G (Spring)
3-0-9 H-LEVEL Grad Credit
A general introduction to manifolds and Lie groups. The role of Lie groups in mathematics and physics. Exponential mapping. Correspondence with Lie algebras. Homogeneous spaces and transformation groups. Adjoint representation. Covering groups. Automorphism groups. Invariant differential forms and cohomology of Lie groups and homogeneous spaces. 18.101 recommended but not required.
S. Carnahan

18.758 Representations of Lie Groups
Prereq: 18.757
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduction to unitary representations of semisimple Lie groups: compact groups and the Borel-Weil theorem; parabolic induction; Zuckerman construction; unipotent representations.
Information: D. A. Vogan

18.769 Topics in Lie Theory
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year.
Information: D. A. Vogan

18.781 Theory of Numbers
Prereq: None
U (Fall)
3-0-9
An elementary introduction to number theory with no algebraic prerequisites. Primes, congruences, quadratic reciprocity, diophantine equations, irrational numbers, continued fractions, partitions.
B. T. Webster

18.782 Introduction to Arithmetic Geometry (New)
Prereq: 18.702
U (Fall)
3-0-9
Uses ideas from algebra to study rational points on plane conics and elliptic curves. Includes an introduction to p-adic numbers and a brief introduction to algebraic geometry.
B. Poonen

18.784 Seminar in Number Theory
Prereq: 18.06 and 18.100; or 18.700 or 18.701
U (Spring)
3-0-9
Topics vary from year to year. Students present and discuss the subject matter. Instruction and practice in written and oral communication provided. Topic for spring 2010: Modular forms. Enrollment limited.
S. Carnahan

18.785 Analytic Number Theory
Prereq: 18.112
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
An introduction to analytic number theory. Riemann zeta function, L-functions, prime number theorem, Dirichlet’s theorem, Riemann Hypothesis and related conjectures. Sieving methods, Linnik’s large sieve, Selberg’s sieve. Applications to distribution of prime numbers. Other topics if time permits. Background in elementary number theory, e.g., 18.781, strongly recommended.
Information: D. A. Vogan

18.786 Algebraic Number Theory
Prereq: 18.100; 18.702
G (Spring)
3-0-9 H-LEVEL Grad Credit
An introduction to algebraic number theory. Dedekind domains, unique factorization of prime ideals. Number fields, splitting of primes, class group. Lattice methods, finiteness of the class number, Dirichlet’s units theorem. Local fields, ramification, discriminants. Background in elementary number theory (e.g., 18.781) strongly recommended.
A. Kumar

18.787 Topics in Number Theory
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year.
Information: D. A. Vogan

18.821 Project Laboratory in Mathematics
Prereq: Two mathematics subjects numbered 18.100 or above
U (Fall, Spring)
3-0-3 Institute LAB
Guided research in mathematics, employing the scientific method. Students confront puzzling and complex mathematical situations, through the acquisition of data by computer, pencil and paper, or physical experimentation, and attempt to explain them mathematically. Students choose three projects from a large collection of options. Each project results in a laboratory report subject to revision; oral presentation on one report in a course conference. Projects drawn from many areas, including dynamical systems, number theory, algebra, fluid mechanics,
asymptotic analysis, knot theory, and probability. Enrollment limited.

Fall: P. Seidel
Spring: D. S. Jerison

18.823 Principles of Mathematics Presentation (18.096)
Prereq: Permission of instructor
U (Fall)
3-1-8

Instruction in preparing and presenting professional papers in mathematics, including a tutorial providing individual guidance in editing and formatting a paper to make it suitable for publication in MIT’s Undergraduate Journal of Mathematics. Students lecture on their papers and on topics of their choice, and write reviews of each other’s lectures. Students must come with a draft containing an adequate amount of technical mathematics, such as a term paper or a research report. Enrollment limited; preference to senior Mathematics majors.

S. L. Kleiman

TOPOLOGY AND GEOMETRY

18.901 Introduction to Topology
Prereq: 18.100 or permission of instructor
U (Fall, Spring)
3-0-9 H-LEVEL Grad Credit (except for Course 18 students)

Introduces topology, covering topics fundamental to modern analysis and geometry. Topological spaces and continuous functions, connectedness, compactness, separation axioms, and selected further topics such as function spaces, metrization theorems, embedding theorems, dimension theory.

Fall: J. R. Munkres
Spring: G. Lusztig

18.904 Seminar in Topology
Prereq: 18.901
U (Spring)
3-0-9

Students present and discuss the subject matter with faculty guidance. Topics include the fundamental group and covering spaces. Instruction and practice in written and oral communication provided. Enrollment limited.

T. A. Putman

18.905 Algebraic Topology I
Prereq: 18.701 or 18.703; 18.901
G (Fall)
3-0-9 H-LEVEL Grad Credit

Review of fundamental group and covering spaces; simplicial, cellular, and singular homology; universal coefficient and Künneth theorems; cohomology, cup product; Poincaré duality.

H. R. Miller

18.906 Algebraic Topology II
Prereq: 18.905
G (Spring)
3-0-9 H-LEVEL Grad Credit

Continues the introduction to Algebraic Topology from 18.905. Topics include basic homotopy theory, spectral sequences, characteristic classes, and cohomology operations.

M. J. Behrens

18.915 Graduate Topology Seminar
Prereq: 18.906
G (Fall)
3-0-9 H-LEVEL Grad Credit

Study and discussion of important original papers in the various parts of algebraic topology. Open to all students who have taken 18.906 or the equivalent, not only prospective topologists.

M. J. Behrens

18.917 Topics in Algebraic Topology
Prereq: 18.906
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Content varies from year to year. Introduces new and significant developments in algebraic topology with the focus on homotopy theory and related areas.

Information: H. R. Miller

18.937 Topics in Geometric Topology
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Content varies from year to year. Introduces new and significant developments in geometric topology.

Information: H. R. Miller

18.950 Differential Geometry
Prereq: 18.100; 18.06, 18.700, or 18.701
U (Fall)
3-0-9 H-LEVEL Grad Credit (except for Course 18 students)

Introduction to differential geometry, centered on notions of curvature. Starts with curves in the plane, and proceeds to higher dimensional submanifolds. Computations in coordinate charts: first and second fundamental form, Christoffel symbols. Discusses the distinction between extrinsic and intrinsic aspects, in particular Gauss’ theorema egregium. The Gauss-Bonnet theorem. Geodesics. Examples such as hyperbolic space.

M. J. Behrens

18.952 Theory of Differential Forms
Prereq: 18.101; 18.700 or 18.701
U (Spring)
3-0-9

Multilinear algebra: tensors and exterior forms. Differential forms on $\mathbb{R}^n$: exterior differentiation, the pull-back operation and the Poincaré lemma. Applications to physics: Maxwell’s equations from the differential form perspective. Integration of forms on open sets of $\mathbb{R}^n$. The change of variables formula revisited. The degree of a differentiable mapping. Differential forms on manifolds and De Rham theory. Integration of forms on manifolds and Stokes’ theorem. The push-forward operation for forms. Thom forms and intersection theory. Applications to differential topology.

V. W. Guillemin

18.965 Geometry of Manifolds
Prereq: 18.101, 18.102, or 18.103
G (Fall)
3-0-9 H-LEVEL Grad Credit

18.966 Geometry of Manifolds
Prereq: 18.965
G (Spring)
3-0-9 H-LEVEL Grad Credit

Differential forms, introduction to Lie groups, the DeRham theorem, Riemannian manifolds, curvature, the Hodge theory. 18.966 is a continuation of 18.965 and focuses more deeply on various aspects of the geometry of manifolds. Contents vary from year to year, and can range from Riemannian geometry (curvature, holonomy) to symplectic geometry, complex geometry and Hodge-Kahler theory, or smooth manifold topology. Prior exposure to calculus on manifolds, as in 18.952, is recommended.

Fall: T. H. Colding
Spring: T. S. Mrowka
18.969 Topics in Geometry
Prereq: 18.965
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Content varies from year to year. Fall 2009: Mirror symmetry. 
P. Seidel

18.979 Graduate Geometry Seminar
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Content varies from year to year. Study of classical papers in geometry and in applications of analysis to geometry and topology. 
Information: T. S. Mrowka

18.994 Seminar in Geometry
Prereq: 18.101, 18.102, 18.103, or 18.112
U (Spring)
3-0-9
Students present and discuss subject matter taken from current journals or books. Topics vary from year to year. Instruction and practice in written and oral communication provided. Enrollment limited. 
Information: R. B. Melrose

18.995–18.998 Special Topics in Mathematics
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for group study of advanced subjects in mathematics not otherwise included in the curriculum. Offerings are initiated by members of the Mathematics faculty on an ad hoc basis, subject to departmental approval. 
Information: H. R. Miller

18.999 Research in Mathematics
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Opportunity for study of graduate-level topics in mathematics under the supervision of a member of the department. For graduate students desiring advanced work not provided in regular subjects. 
Information: B. Poonen, G. Staffilani

18.UR Undergraduate Research
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Undergraduate research opportunities in mathematics. Permission required in advance to register for this subject. For further information, consult the departmental coordinator. 
Information: H. R. Miller

18.ThG Graduate Thesis
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research leading to the writing of a PhD thesis; to be arranged by the student and an appropriate MIT faculty member. 
Information: B. Poonen, G. Staffilani

18.CME Study at Cambridge University
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit
Provides credit for students studying at Cambridge University under the Cambridge-MIT Exchange program. Credit may be used to satisfy specific SB degree requirements. Consult with department and CME office. 
H. R. Miller
Bachelor of Science in Mathematics/Course 18

General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [one subject can be satisfied by 18.03 or 18.034 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
</tbody>
</table>

Total GIR Subjects Required for SB Degree: 17

Communication Requirement

The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

Required Subjects

One of the following two subjects:
18.03 or 18.034 Differential Equations, 12; Calculus II (GIR)

Restricted Electives

To satisfy the requirements that students take two CI-M subjects, students must take two of the following subjects: 18.100C, 18.104, 18.304, 18.384, 18.424, 18.434, 18.504, 18.704, 18.784, 18.821, 18.823, 18.904, or 18.994 or one from the above list and one of the following subjects: 6.033, 8.06, or 18.310C.

General Mathematics Option

Eight 12-unit subjects of different content, including at least six advanced subjects (first decimal digit one or higher). One of these eight subjects must be 18.06, 18.700, or 18.701.

Applied Mathematics Option

18.310 or 18.310C Principles of Applied Mathematics, 12; Calculus II (GIR)
18.311 Principles of Applied Mathematics, 12; Calculus II (GIR), 18.03*

One of the following two subjects:
18.04 Complex Variables with Applications, 12; Calculus II (GIR), 18.03*
18.112 Functions of a Complex Variable, 12; 18.100, 18.06*

One of the following two subjects:
18.06 Linear Algebra, 12; REST; Calculus II (GIR)
18.700 Linear Algebra, 12; REST; Calculus II (GIR)

Four additional 12-unit Course 18 subjects from the following two groups with at least one subject from each group:

Group I—Probability and statistics, combinatorics, computer science
Group II—Numerical analysis, physical mathematics, nonlinear dynamics

Theoretical Mathematics Option

18.100 Analysis I, 12; Calculus II (GIR), 18.03*
18.701 Algebra I, 12; 18.700*
18.702 Algebra II, 12; 18.701
18.901 Introduction to Topology, 12; 18.100*

One of the following subjects:
18.101 Analysis II, 12; 18.100, 18.06*
18.102 Introduction to Functional Analysis, 12; 18.100, 18.06*
18.103 Fourier Analysis—Theory and Applications, 12; 18.100, 18.06*

An undergraduate seminar from the following list: 18.104, 18.504, 18.704, 18.784, 18.904, 18.994 (12 units).

Two additional Course 18 subjects of essentially different content, with the first decimal digit one or higher (24 units)

Departmental Program Units That Also Satisfy the GIRs

(12)

Unrestricted Electives

60

Total Units Beyond the GIRs Required for SB Degree: 180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student's departmental program will count toward one or the other, but not both.

Notes

*Alternate prerequisites and corequisites are listed in the subject description.

**Students may substitute the more advanced subject 18.701 Algebra I.

***A list of acceptable subjects is available in Room 2-108 and on the Mathematics Department website.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
## Bachelor of Science in Mathematics with Computer Science/Course 18-C

### General Institute Requirements (GiRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
<th>Units</th>
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<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 18.03, 18.034, 18.06, or 18.700 in the Departmental Program]</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

### Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- and 2 subjects designated as Communication Intensive in the Major (CI-M).

### PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

#### Required Subjects

- 18.03 or 18.034 Differential Equations, 12, REST; *Calculus II (GIR)*
- 18.06 or 18.700 Linear Algebra, 12, REST; *Calculus II (GIR)*
- 18.410J Design and Analysis of Algorithms, 12; 6.006*
- 6.01 Introduction to EECS I, 12, 1/2 LAB
- 6.006 Introduction to Algorithms, 12; 6.01, 18.062J

One subject from each of the following three groups:
- 18.062J Mathematics for Computer Science, 12; *Calculus I (GIR)*
- 18.310 or 18.310C Principles of Applied Mathematics, 12; *Calculus II (GIR)*
- 18.400J Automata, Computability, and Complexity, 12; 18.062J
- 18.404J Theory of Computation, 12; 18.062J*
- 6.005 Principles of Software Development, 12; 6.01, 18.062J*
- 6.033 Computer System Engineering, 12; 6.004

#### Restricted Electives

Four additional 12-unit subjects from Course 18 and one additional subject of at least 12 units from Course 6.

The Course 6 subject may be 6.02, 6.041, 6.17x, a Foundation or Header subject, or, with the permission of the Department of Mathematics, an advanced Course 6 subject. The overall program must consist of subjects of essentially different content, and must include at least five Course 18 subjects with a first decimal digit of 1 or higher.

To satisfy the requirements that students take two CI-M subjects, students must take two of the following subjects: 18.100C, 18.104, 18.304, 18.424, 18.434, 18.504, 18.704, 18.784, 18.821, 18.823, 18.904, or 18.994 or one from the above list and one of the following subjects: 6.033, 8.06, or 18.310C.

### Departmental Program Units That Also Satisfy the GiRs

(24)

### Unrestricted Electives

48

### Total Units Beyond the GiRs Required for SB Degree

180

No subject can be counted both as part of the 17-subject GiRs and as part of the 180 units required beyond the GiRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

### Notes

* Alternate prerequisites and corequisites are listed in the subject description.

(1) Recommended alternative.

For an explanation of credit units, or hours, please refer to the online help in the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
20.020 Introduction to Biological Engineering Design
Prereq: None
U (Spring)
3-3-3
A project-based introduction to the engineering of synthetic biological systems. Throughout the term, students develop projects that are responsive to real-world problems of their choosing, and whose solutions depend on biological technologies. Lectures, discussions, and studio exercises will introduce (1) components and control of prokaryotic and eukaryotic behavior, (2) DNA synthesis, standards, and abstraction in biological engineering, and (3) issues of human practice, including biological safety; security; ownership, sharing, and innovation; and ethics. Preference to freshmen.

N. Kuldel
t

20.102 Macroepidemiology and Population Genetics
(Subject meets with 20.215)
Prereq: Calculus I (GIR)
U (Fall)
3-0-9
Analyses of major causes of mortality in the US since 1900: cancer, cardiovascular and cerebrovascular diseases, diabetes, infectious diseases. Analytical models to derive estimates for historically variant population risk factors and physiological rate parameters. Analysis of familial data to separately estimate inherited and environmental risks. Basic population genetics of dominant, recessive, and non-deleterious inherited risk factors.

W. G. Thilly

20.104 Environmental Risks for Common Disease
(Same subject as 1.081), ESD.053)
Prereq: Biology (GIR), Chemistry (GIR)
U (Spring)
3-0-9

W. G. Thilly, R. McCunney

20.106 Systems Microbiology
(Same subject as 1.084j)
Prereq: Chemistry (GIR), Biology (GIR)
U (Fall)
3-0-9
Introductory microbiology from a systems perspective. Considers microbial diversity, population dynamics, and genomics. Emphasize the delicate balance between microbes and humans, and changes that result in the emergence of infectious diseases and antimicrobial resistance. Case study approach covers topics such as vaccines, toxins, biodefense, and infections including Legionnaire’s disease, tuberculosis, Helicobacter pylori, and plague.

E. DeLong

20.109 Laboratory Fundamentals in Biological Engineering
Prereq: Biology (GIR) Chemistry (GIR), 6.00, 18.03; 20.110 or 20.111
U (Fall, Spring)
2-8-5 Institute LAB
Introduces experimental biochemical and molecular techniques from a quantitative engineering perspective. Experimental design, data analysis, and scientific communication form the underpinnings of this subject. Examples of discovery-based experimental modules include: DNA Engineering in which students design, construct, and use genetic material; Parts Engineering, which emphasizes protein design and quantitative assessment of protein performance; Systems Engineering, in which students consider genome-wide consequences of genetic perturbations; and Biomaterials Engineering, in which students use biologically-encoded devices to design and build materials. Limited enrollment; priority to BE majors.

Fall: A. Belcher, N. Kuldel, B. P. Engelward
Spring: A. Jasanoff, J. Niles, A. Stachowiak

20.110 Thermodynamics of Biomolecular Systems
(Same subject as 2.772j)
Prereq: Calculus II (GIR), Chemistry (GIR)
U (Fall)
5-0-7 REST
Credit cannot also be received for 7.10

L. G. Griffith, K. Hamad-Schifferi

20.111 Physical Chemistry of Biomolecular Systems
(Same subject as 7.10)
Prereq: Calculus II (GIR), Chemistry (GIR), Physics I (GIR); Coreq: Physics II (GIR)
U (Fall)
5-0-7
See description under subject 7.10).

Staff

20.200 Biological Engineering Seminar
Prereq: Open only to BE graduate students, or by permission of instructor
G (Fall, Spring)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Weekly one-hour seminars covering graduate student research and presentations by invited speakers.

J. S. Wishnok

20.201 Mechanisms of Drug Actions
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Chemical and biological analysis of the metabolism and distribution of drugs and chemicals in animals and humans, and the mechanisms by which they cause therapeutic and toxic responses. Metabolism, pharmacology and
toxicity as a basis for drug development. Group project analysis of specific drugs and their role in the market. P. C. Dedon, S. R. Tannenbaum

20.202 In vivo models: Principles and Practices
Prereq: Permission of instructor
G (Spring)
1-1-4 H-LEVEL Grad Credit
Selected aspects of anatomy, histology, immuno-cytochemistry, in situ hybridization, physiology, and cell biology of mammalian organisms and their pathogens. Subject material integrated with principles of toxicology, in vivo genetic engineering, and molecular biology. A lab/demonstration period each week involves experiments in anatomy (in vivo), physiology, and microscopy to augment the lectures. Offered first half of spring term.
J. G. Fox, B. Marini, M. Whary

20.213 DNA Damage and Genomic Instability
Prereq: 5.07, 7.05, permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
Recent progress has resulted in the identification of dozens of genes that, when mutated, promote tumorigenesis. However, it is not yet clear what causes these mutations. Subject analyzes the chemistry of DNA damaging agents, and continues with analysis of the mutagenic and toxic consequences of modifications to DNA structure. The contrasting perspective that normal DNA processing leads to mutations is also presented. The biochemistry and molecular mechanisms of DNA replication, DNA repair, and recombination form the foundation of the subject.
P. C. Dedon, B. P. Engelward

20.215 Epidemiology, Population Genetics and Cell Biology of Human Cancers
(Subject meets with 20.102)
Prereq: Calculus II (GIR), 1.00
G (Fall)
3-0-15 H-LEVEL Grad Credit
Logic and technology needed to discover genetic and environmental causes and accelerating factors for common human cancers. Analyses of large organized historical public health databases using quantitative carcinogenesis cascade models. Java-based model construction for mono- and multi-geic inherited risk for late onset (sporadic) cancers. Analyses of historical and clinical data to define role of environmental risk factors. Graduate students complete additional work.
W. G. Thilly

20.219 Selected Topics in Toxicology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Detailed discussion of selected topics of current interest. Classwork in various areas not covered by regular subjects.
Staff

20.309) Instrumentation and Measurement for Biological Systems
(Same subject as 2.673J, 6.122J, MAS.402J)
Prereq: Biology (GIR), Physics II (GIR), 6.00, 18.03; 2.001, 20.310, or 6.02; or permission of instructor; Coreq: 20.330
U (Fall, Spring)
3-6-3
Sensing and measurement aimed at quantitative molecular/cell/tissue analysis in terms of genetic, biochemical, and biophysical properties. Methods include light and fluorescence microscopies, electronic circuits, and electromechanical probes (atomic force microscopy, optical traps, MEMS devices). Application of statistics, probability, signal and noise analysis, and Fourier techniques to experimental data. Final design project emphasizes utilization of principles underlying biological instrumentation. Preference to juniors and seniors.
Fall: S. Manalis, P. T. So, S. Wasserman
Spring: E. Boyden, S. Wasserman, M. F. Yanik

20.310 J molecular, Cellular, and tissue Biomechanics
(Subject meets with 2.797J, 3.053J, 6.024J)
Prereq: 2.370 or 2.772J; 18.03 or 3.016; Biology (GIR)
U (Spring)
4-0-8
See description under subject 2.797).
R. D. Kamm

20.320 Analysis of Biomolecular & Cellular Systems
Prereq: 20.110, 18.03, 6.00; Coreq: 5.07
U (Fall)
4-0-8
Analysis of molecular and cellular processes across a hierarchy of scales, including genetic, molecular, cellular, and cell population levels. Topics include gene sequence analysis, molecular modeling, metabolic and gene regulation networks, signal transduction pathways and cell populations in tissues. Emphasis on experi-
mental methods, quantitative analysis, and computational modeling.
F. White, E. Fraenkel

20.330J Fields, Forces and Flows in Biological Systems
(Same subject as 2.793J, 6.023J)
Prereq: 2.005, 6.021, 20.320 or permission of instructor
U (Spring)
4-0-8
Introduction to electric fields, fluid flows, transport phenomena and their application to biological systems. Flux and continuity laws, Maxwell’s equations, electro-quasistatics, electro-chemical-mechanical driving forces, conservation of mass and momentum, Navier-Stokes flows, and electrokinetics. Applications include biomolecular transport in tissues, electrophoresis, and microfluidics.
J. Han, L. Griffith

20.340 J Materials for Biomedical Applications
(Same subject as 3.051J)
(Subject meets with 3.962J, 20.462J)
Prereq: Chemistry (GIR), Biology (GIR), 3.034, 3.012 or 3.046; or permission of instructor
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9
See description under subject 3.051J.
D. Irvine

20.342 Molecular Structure of Biological Materials
(Subject meets with 20.442)
Prereq: 5.07 or 7.05; permission of instructor
U (Fall)
3-0-9
Basic molecular structural principles of biological materials. Molecular structures of various materials of biological origin, including collagen, silk, bone, protein adhesives, GFP, self-assembling peptides. Molecular design of new biological materials for nanotechnology, biocomputing and regenerative medicine. Graduate students are expected to complete additional coursework.
S. Zhang
20.360] Tissue Engineering for Analysis, Prevention, and Treatment of Human Disease
(Same subject as 10.499J)
Prereq: 5.07 or 7.05; 7.03; 18.03; 20.110 or 5.60
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-6
Analysis of fundamental processes in tissue engineering with an emphasis on use of comparative animal models and in vitro tissue engineered models to understand human disease and develop therapies for human disease and for regenerating human tissues and organs. Using representative examples of metabolic tissue (e.g., liver) and connective tissue (e.g., bone), design principles and engineering approaches (e.g., use of synthetic materials) for controlling receptor-mediated processes such as cell migration, growth, and differentiation. Mass transfer limitations in design of devices for cell encapsulation and in scaffold-guided regeneration. Guided organization of multicellular structures. Current clinical prospects.
Staff

20.361J Molecular and Engineering Aspects of Biotechnology
(Same subject as 7.37J, 10.441J)
Prereq: 20.110J, 2.005, 3.012, or 5.60; 7.06; or permission of instructor
U (Spring)
4-0-8
See description under subject 7.37J.
H. Lodish, L. G. Griffith

20.370J Cellular Biophysics
(Same subject as 2.79J, 6.021J)
Subject meets with 2.79J, 6.521J, 20.470J, HST.541J
Prereq: Physics II (GIR), 18.03; 2.005, 6.002, 6.003, 6.071, 10.301, or permission of instructor
U (Fall)
5-2-5
See description under subject 6.021J.
D. M. Freeman, J. Han, J. Waldman

20.371J Quantitative Systems Physiology
(Same subject as 2.79J, 6.022J, HST.542J)
Subject meets with 2.79J, 6.522J, 20.471J
Prereq: Physics II (GIR), 18.03, or permission of instructor
U (Spring)
4-2-6
See description under subject 6.022J.
R. G. Mark, C. M. Stultz

20.380 Biological Engineering Design
Prereq: 7.06, 20.309, 20.330
U (Spring)
5-0-7
Illustrates how knowledge and principles of biology, biochemistry, and engineering are integrated to create new products for societal benefit. Uses case-study format to examine recently developed products of pharmaceutical and biotechnology industries: how a product evolves from initial idea, through patents, testing, evaluation, production, and marketing. Emphasizes scientific and engineering principles, as well as the responsibility scientists, engineers, and business executives have for the consequences of their technology. Instruction and practice in written and oral communication provided. Enrollment limited; preference to Course 20 undergraduates.
J. M. Essigmann, D. J. Irvine

20.385 Advanced Topics in Synthetic Biology (New)
Prereq: Permission of instructor
U (Spring)
3-3-3
Provides an in-depth understanding of the state of research in synthetic biology. Critical evaluation of primary research literature covering a range of approaches to the design, modeling and programming of cellular behaviors. Focuses on developing the skills needed to read, present and discuss primary research literature, and to manage and lead small teams. Students mentor a small undergraduate team of 20.020 students. Open to advanced students with appropriate background in biology.
N. Kuldell

20.390 Foundations of Computational and Systems Biology
(Subject meets with 7.36, 7.91J, 20.490J)
Prereq: 7.05 or 5.07; or Biology (GIR) and 6.001; or permission of instructor
U (Spring)
3-0-9
Introduction to computational biology emphasizing the fundamentals of nucleic acid and protein sequence and structural analysis, as well as the analysis of complex biological systems. Principles and methods used for sequence alignment, motif finding, expression array analysis, structural modeling, structure prediction and network modeling. Techniques include dynamic programming, Markov models, clustering techniques, dead-end elimination and energy minimization approaches. Exposure to currently emerging research areas. Designed for advanced undergraduates and graduate students with strong backgrounds in either molecular biology or computer science. Some foundational material covering basic programming skills, probability and statistics is provided for students with non-quantitative backgrounds. Enrollment limited to 60.
M. Yaffe, C. Burge, A. Keating

20.400] Perspectives in Biological Engineering
(Same subject as 7.548J)
Prereq: Permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
An in-depth presentation of how engineering and biological approaches can be combined to solve problems in science and technology, emphasizing integration of biological information and methodologies with engineering analysis, synthesis, and design. Emphasis on molecular mechanisms underlying cellular processes, including signal transduction, gene expression networks, and functional responses. Enrollment restricted to Biological Engineering and Biology graduate students.
F. White, E. Fraenkel

20.409 Biological Engineering II: Instrumentation and Measurement
(Subject meets with 2.673J, 6.122J, 20.309J, MAS.402J)
Prereq: 18.03
G (Fall, Spring)
2-7-3
Sensing and measurement aimed at quantitative molecular/cell/tissue analysis in terms of genetic, biochemical, and biophysical properties. Methods include light and fluorescence microscopies, and electro-mechanical probes (atomic force microscopy, laser and magnetic traps, MEMS devices). Application of statistics, probability and noise analysis to experimental data. Enrollment limited to 5 graduate students.
S. Manalis, P. T. So, S. Wasserman

20.410J Molecular, Cellular, and Tissue Biomechanics
(Same subject as 2.79J, 3.97J, 6.524J, 10.537J)
Prereq: Biology (GIR), 2.002, 2.006, 6.013, 10.301, or 10.302
G (Spring)
3-0-9 H-LEVEL Grad Credit
Develops and applies scaling laws and the methods of continuum mechanics to biomechanical phenomena over a range of length scales. Topics include structure of tissues and the molecular basis for macroscopic properties; chemical and electrical effects on mechanical behavior; cell mechanics, motility and adhesion; biome-
branes; biomolecular mechanics and molecular motors. Experimental methods for probing structures at the tissue, cellular, and molecular levels. A. J. Grodzinsky, M. Bathe

20.411J Cell-Matrix Mechanics
(Same subject as 2.785J, HST.523J)
Prereq: 2.005 or 5.60; Biology (GIR); Chemistry (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.785J.
I. V. Yannas, M. Spector

20.420J Biomolecular Kinetics and Cellular Dynamics
(Same subject as 10.538J)
Prereq: 7.05, 7.06, 18.03
G (Fall)
3-0-9 H-LEVEL Grad Credit
Fundamental analysis of biological rate processes using approaches from biomolecular reaction kinetics and dynamical systems engineering. Topics include binding and hybridization interactions, enzyme reactions, metabolic cycles, gene regulation, receptor/ligand trafficking systems, intra- and intercellular signaling, and cell population dynamics.
K. D. Wittrup, B. Tidor

20.430J Fields, Forces, and Flows in Biological Systems
(Same subject as 2.795J, 6.561J, 10.539J, HST.544J)
Prereq: 6.013, 2.005, 10.302, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Molecular diffusion, diffusion-reaction, conduction, convection in biological systems; fields in heterogeneous media; electrical double layers; Maxwell stress tensor, electrical forces in physiological systems. Fluid and solid continua: equations of motion useful for porous, hydrated biological tissues. Case studies of membrane transport, electrode interfaces, electrical, mechanical, and chemical transduction in tissues, convective-diffusion/reaction, electrophoretic, electroosmotic flows in tissues/MEMS, and ECG. Electromechanical and physicochemical interactions in cells and biomaterials; musculoskeletal, cardiovascular, and other biological and clinical examples.
A. J. Grodzinsky, D. Lauffenburger

20.440 Analysis of Biological Networks
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Analyzes complex biological processes from the molecular, cellular, extracellular, and organ levels of hierarchy. Emphasis placed on the basic biochemical and biophysical principles that govern these processes. Examples of processes to be studied include chemotaxis, the fixation of nitrogen into organic biological molecules, growth factor and hormone mediated signaling cascades, and signaling cascades leading to cell death in response to DNA damage. In each case, the availability of a resource, or the presence of a stimulus, results in some biochemical pathways being turned on while others are turned off. Examines the dynamic aspects of these processes and details how biochemical mechanistic themes impinge on molecular-cellular-tissue-organ level functions. Chemical and quantitative view of the interplay of multiple pathways as biological networks. Preparation of a unique grant application in an area of biological networks.
R. Sasishekaran, R. C. Dedon, B. Engelward, J. Essigman

20.440J Biomaterials: Tissue Interactions
(Same subject as 2.79J, 3.96J, HST.522J)
Prereq: Chemistry (GIR); 2.005 or 5.60; Biology (GIR)
G (Fall)
3-0-9 H-LEVEL Grad Credit
Principles of materials science and cell biology underlying the design of medical implants, artificial organs, and matrices for tissue engineering. Methods for biomaterials surface characterization and analysis of protein adsorption on biomaterials. Molecular and cellular interactions with biomaterials are analyzed in terms of unit cell processes, such as matrix synthesis, degradation, and contraction. Mechanisms underlying wound healing and tissue remodeling following implantation in various organs. Tissue and organ regeneration. Design of implants and prostheses based on control of biomaterials-tissue interactions. Comparative analysis of intact, biodegradable, and bioreplaceable implants by reference to case studies. Criteria for restoration of physiological function for tissues and organs.
I. V. Yannas, M. Spector

20.442 Molecular Structure of Biological Materials
(Subject meets with 20.342)
Prereq: 5.07 or 7.05; permission of instructor
G (Fall)
3-0-9
See description under subject 20.342.
S. Zhang

20.445J Methods and Problems in Microbiology
(Same subject as 1.86J, 7.492J)
Prereq: permission of instructor or Coreq: 7.493
G (Fall)
3-0-9 [P/D/F] H-LEVEL Grad Credit
See description under subject 7.492J.
L. Samson, M. Polz

20.446J Microbial Genetics and Evolution
(Same subject as 1.87J, 7.493J)
Prereq: 7.03, 7.05, 7.28 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 7.493J.
A. D. Grossman, E. Alm

20.450 Molecular and Cellular Pathophysiology
Prereq: 20.420 and 20.440, or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
Fundamentals of tissue and organ response to injury are examined from a molecular and cellular perspective. Special emphasis on disease states that bridge infection, inflammation, immunity, and cancer. Systems approach to pathophysiology includes lectures, critical evaluation of recent scientific papers, and student projects and presentations.
J. Niles

20.451J Design of Medical Devices and Implants
(Same subject as 2.782J, HST.524J)
Prereq: 2.79J or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.782J.
I. V. Yannas, M. Spector

20.452J Principles of Neuroengineering
(Same subject as 9.422J, MAS.881J)
Prereq: 8.03, 6.003, and 9.01; or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject MAS.881J.
E. S. Boyden
20.453J Biomedical Information Technology
(Same subject as 2.771J, HST.958J)
Prereq: Permission of instructor
G (fall)
3-0-9 H-LEVEL Grad Credit

Design of contemporary information systems for biological and medical data. Examples from biology and medicine illustrate complete life cycle information systems, beginning with data acquisition, following to data storage and, finally, to retrieval and analysis. Design of appropriate databases, client-server strategies, data interchange protocols, and computational modeling architectures. Demonstrates the use of ontologies and the semantic. Students are expected to have some familiarity with scientific application software and a basic understanding of at least one contemporary programming language (e.g., C, C++, Java, Lisp, Perl, Python). A major term project is required of all students. This subject is part of the Singapore-MIT Alliance and presented as a video simulcast with lectures originating in both locations. Open to motivated seniors with a strong interest in biomedical engineering and information system design, and the ability to carry out a significant independent project.

C. F. Dewey, Jr., S. Bhowmik (NTU, Singapore)

20.454J Neurotechnology Ventures
(Same subject as 9.455J, 15.128J, MAS.883J)
Prereq: Permission of instructor
G (fall)
2-0-7 H-LEVEL Grad Credit

See description under subject MAS.883J.
E. S. Boyden, R. Ellis-Behnke, J. Bonsen

20.462J Molecular Principles of Biomaterials
(Same subject as 3.962J)
(Subject meets with 3.051J, 20.340J)
Prereq: Permission of instructor
Acad year 2009–2010: Not offered
Acad year 2010–2011: G (spring)
3-0-9 H-LEVEL Grad Credit

Analysis and design at a molecular scale of materials used in contact with biological systems, including biotechnology and biomedical engineering. Topics include molecular interactions between bio- and synthetic molecules and surfaces; design, synthesis, and processing approaches for materials that control cell functions; and application of state-of-the-art materials science to problems in tissue engineering, drug delivery, biosensors, and cell-guiding surfaces.

Staff

20.470J Cellular Biophysics
(Same subject as 2.794J, 6.521J, HST.541J)
(Subject meets with 2.791J, 6.021J, 20.370J)
Prereq: Physics II (GIR); 18.03; 2.005, 6.002, 6.003, 6.071, 10.301, 20.110, or permission of instructor
G (fall)
5-2-5 H-LEVEL Grad Credit

See description under subject 6.521J.
D. M. Freeman, J. Han

20.471J Quantitative Physiology: Organ Transport Systems
(Same subject as 2.796J, 6.522J)
(Subject meets with 2.792J, 6.022J, 20.371J, HST.542J)
Prereq: 2.006 or 6.013; 6.021J
G (spring)
4-2-6 H-LEVEL Grad Credit

See description under subject 6.522J.
R. G. Mark, C. M. Stultz

20.472J Neuroimaging Cells and Circuits
(Same subject as 9.472J)
Prereq: Permission of instructor
Acad year 2009–2010: Not offered
Acad year 2010–2011: G (fall)
3-0-9

See description under subject 9.472J.
A. Jasanoff, P. T. So

20.482J Foundations of Algorithms and Computational Techniques in Systems Biology
(Same subject as 6.581J)
Prereq: 6.021J, 6.034, 6.046, 6.336J, 7.91J, 18.417, or permission of instructor
G (spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 6.581J.
B. Tidor, J. K. White

20.483J Noninvasive Imaging in Biology and Medicine
(Same subject as 9.173J, 22.56J, HST.561J)
Prereq: 18.03; 8.03, or permission of instructor
Acad year 2009–2010: Not offered
Acad year 2010–2011: G (fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 22.56J.
A. Jasanoff

20.485 Tools for Assessing Biological Function
Prereq: 5.43, 5.07 or 7.05, 5.47 or 5.52
G (spring)
3-0-9

Contemporary bioorganic chemistry and chemical biology, emphasizing the application of chemical approaches to interrogate biochemical function. Additionally, techniques for quantitative analysis of macromolecular or systems level characteristics such as protein expression, interaction and signaling will be highlighted. Biomarkers and drug effects are discussed combining the chemistry of small molecules and the biology of the cell to identify therapeutic applications in drug discovery. Meets with 5.55 for first half of term.

B. Imperiali, F. White

20.486J Case Studies and Strategies in Drug Discovery and Development
(Same subject as 7.549J, 15.137J, HST.916J)
Prereq: Permission of instructor
G (spring)
2-0-4 H-LEVEL Grad Credit

The stages in drug discovery and development begin with target identification and end with the submission of preclinical and clinical data to the regulatory authorities. Following identification of a lead compound, there is optimization of structures for pharmaceutical properties, bioavailability, and safety. Subject relies on actual cases presented by the scientist(s) involved in discovery and drug development. A major goal is to analyze the cases and determine how the discovery and development process might be influenced by new and future technologies.

S. R. Tonnembaum, A. J. Sinskey, E. Berndt

20.487J Optical Microscopy and Spectroscopy for Biology and Medicine
(Same subject as 2.715J)
Prereq: Permission of instructor
G (fall)
3-0-9

See description under subject 2.715J.
P. T. So, C. Sheppard

20.490J Foundations of Computational and Systems Biology
(Same subject as 7.91J)
(Subject meets with 7.36, 20.390)
Prereq: Biology (GIR); 7.05 or 5.07; 1.00, 1.001, or 6.00; or permission of instructor
G (spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 7.91J.
C. Burge, A. Keating
20.507J Biological Chemistry I
(Same subject as 5.07J)
Prereq: 5.12
U (Fall)
4-0-0 REST
See description under subject 5.07J.
J. Essigmann, J. Stubbe

20.554J Frontiers in Chemical Biology (New)
(Same subject as 5.54J, 7.540J)
Prereq: 5.13, 5.07, 7.06, permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 5.54J.
B. Imperiali, S. O’Connor

20.901 Special Topics in Toxicology and Environmental Health
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit
Program of study to be arranged by the student and a BE faculty member, leading to the writing of a substantive paper. Minimum of 12 units required.
Staff

20.902 Special Topics in Biological Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Opportunity for individual or group study of biological engineering not otherwise included in the curriculum. To be arranged by the student and a faculty member. Students write a substantive paper. Minimum 12 units required.
Staff

20.903 Special Topics in Biological Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Opportunity for individual or group study of biological engineering not otherwise included in the curriculum. To be arranged by the student and a faculty member.
Staff

20.920 Practical Work Experience
Prereq: None
U (Fall, IAP, Spring, Summer)
0-1-0 [P/D/F]
For Course 20 students participating in off-campus work experiences in biological engineering. Before registering for this subject, students must have an employment offer from a company or organization and must identify a BE supervisor. Upon completion of the work, student must submit a letter from the employer describing the work accomplished, along with a substantive final report from the student approved by the MIT supervisor. Subject to departmental approval. Consult departmental undergraduate office.
Staff

20.947–20.949 Special Topics in Biological Engineering
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for individual or group study of biological engineering not otherwise included in the curriculum. To be arranged by the student and a faculty member.
Staff

20.950 Research Problems in Biological Engineering
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Directed research in the fields of bioengineering and environmental health. Open only to BE students.
Staff

20.951 Thesis Proposal
Prereq: Permission of instructor
G (Fall, Spring, Summer)
0-24-0 [P/D/F]
Thesis proposal research and presentation to the thesis committee.
Staff

20.952 Special Topics in Biological Engineering
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Detailed discussion of selected topics of current interest. Classwork in various areas not covered by regular subjects.
Staff

20.960 Teaching Experience in Biological Engineering
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
For qualified graduate students interested in teaching. Tutorial, laboratory, or classroom teaching under the supervision of a faculty member. Total enrollment limited by availability of suitable teaching assignments.
Staff

20.EPW UPOP IAP Workshop
Engineering School-Wide Elective Subject
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW)
Prereq: None
U (IAP)
3-0-0 [P/D/F]
See description under subject 2.EPW.
S. Luperfoy

20.ThG Graduate Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research leading to the writing of an SM or PhD thesis; to be arranged by the student and the MIT faculty advisor.
Staff

20.UR Undergraduate Research Opportunities
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
20.URG Undergraduate Research Opportunities
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Emphasizes direct and active involvement in laboratory research in bioengineering or environmental health. May be extended over multiple terms.
S. Manalis
### Bachelor of Science in Biological Engineering/Course 20

#### General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>[can be satisfied by 5.12 and 18.03 in the Course 20 Program]</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 20.109]</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td>17</td>
</tr>
</tbody>
</table>

#### Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

#### PLUS Course 20 Program

<table>
<thead>
<tr>
<th>Subject names below are followed by credit units, and by prerequisites if any (corequisites in italics).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Core Subjects</td>
</tr>
<tr>
<td>18.03 Differential Equations, 12; REST; <em>Calculus II (GIR)</em></td>
</tr>
<tr>
<td>20.110 Thermodynamics of Biomolecular Systems, 12; <em>Calculus II (GIR), Chemistry (GIR)</em></td>
</tr>
<tr>
<td>5.12 Organic Chemistry, 12; REST; <em>Chemistry (GIR)</em></td>
</tr>
<tr>
<td>20.109 Laboratory Fundamentals in Biological Engineering, 15, LAB, CI-M; <em>Biology (GIR), Chemistry (GIR); permission of instructor</em></td>
</tr>
<tr>
<td>7.03 Genetics, 12; <em>Biology (GIR)</em></td>
</tr>
<tr>
<td>6.00 Introduction to Computer Science and Programming, 12</td>
</tr>
<tr>
<td>5.07 Biological Chemistry I, 12, REST; 5.12 or 7.05 General Biochemistry, 12, REST; <em>Biology (GIR); or permission of instructor</em></td>
</tr>
<tr>
<td>7.06 Cell Biology, 12; <em>7.03, 7.05</em></td>
</tr>
<tr>
<td>20.310 Molecular, Cellular, and Tissue Biomechanics, 12; 18.03 or 5.016; <em>Biology (GIR); 2.370 or 20.110J/2.772</em></td>
</tr>
<tr>
<td>20.320 Analysis of Biomolecular and Cellular Systems, 12; 20.110J/2.772; 18.03, 6.00; 5.07 or 7.05</td>
</tr>
<tr>
<td>20.330 Fields, Forces, and Flows in Biological Systems, 12; 2.005, 6.021, 20.320, or permission of instructor</td>
</tr>
<tr>
<td>20.309 Biological Engineering II: Instrumentation and Measurement, 15; 18.03</td>
</tr>
<tr>
<td>20.380 Senior Biological Engineering Design, 12, CI-M; 7.06, 20.309, 20.330</td>
</tr>
</tbody>
</table>

| Restricted Electives (Tracks TBD)                                                                       | 21–24   |

| Departmental Program Units That Also Satisfy the GIRs                                                   | (36)    |

| Unrestricted Electives                                                                                   | 48      |

| **Total Units Beyond the GIRs Required for SB Degree**                                                  | 195–198 |

No subject can be counted both as part of the 17-subject GIRs and as part of the 192 units required beyond the GIRs. Every subject in the student’s Departmental Program will count toward one or the other, but not both.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
To register for individual research or thesis in a specific humanities section, see the section’s subject listings.

**21.ThT Humanities Pre-Thesis Tutorial**  
Prereq: As specified for particular field  
U (Fall, Spring)  
1-0-5  
Can be repeated for credit  
Definition of and early-stage work on thesis project leading to 21.ThU Undergraduate Thesis in Humanities. Taken during the first term of the student’s two-term commitment to the thesis project. Student works closely with an individual faculty tutor. Required for all students in Course 21, and those doing 21-E and 21-S degrees, for whom the thesis is a degree requirement.  
*Consult D. K. Fitzgerald*

**21.ThU Undergraduate Thesis in Humanities**  
Prereq: 21.ThT  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit  
Completion of work on the senior major thesis under supervision of a faculty tutor. Includes oral presentation of thesis progress early in the term, assembling and revising the final text, and meeting at the close with a committee of faculty evaluators to discuss the successes and limitations of the project. Required for most students in Course 21 and those doing 21-E and 21-S degrees. (See degree requirements in specific fields.)  
*Consult D. K. Fitzgerald*

**21.URG Research in Humanities**  
Prereq: None  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit  
Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.  
*Consult D. K. Fitzgerald*

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### Bachelor of Science in Humanities/Course 21

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**  
17

**Communication Requirement**  
The program includes a Communication Requirement of 4 subjects:  
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**

| Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics). |
|-------------------------------------------------|-------------------------------------------------|
| Restricted Electives                              | 126–162                                        |
| German                                            | 8 elective subjects in the field (which may include a pre-thesis and a thesis), plus a four-subject cluster(2) |
| To satisfy the requirement that students complete two Communication Intensive subjects in the major, students must take 21F.406 and 21F.407. Registration for 21F.406 and 21F.407 must be simultaneous with one of 21F.412, 21F.414, 21F.415, or 21F.416. |

**Major Departures**  
The restricted electives for the major departure fields are determined in consultation with the faculty advisor in the chosen field.  
Each major departure program must include two Communication Intensive major subjects, usually chosen from the subjects designated as CI-M for major programs in adjacent disciplines.

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**Departmental Program Units That Also Satisfy the GIRs**  
(27–36)

| Unrestricted Electives | 45–90 |

**Total Units Beyond the GIRs Required for SB Degree**  
180

*No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.*

**Notes**

1. Only one subject used to meet the distribution element of the Humanities, Arts, and Social Sciences Requirement may be counted toward the humanities component of these degree programs.
2. The cluster is usually formed within a single second discipline of the humanities, arts, or social sciences. In special cases, it may draw together subjects from different disciplines to form a coherent grouping.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule,  
[http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi)
Bachelor of Science in Humanities and Engineering/Course 21E, Bachelor of Science in Humanities and Science/Course 21S

General Institute Requirements (GIRs)\(^{(1)}\) Subjects

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Distribution subjects can be satisfied by subjects in the Departmental Program</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

Communication Requirement
The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H), and 2 subjects designated as Communication Intensive in the Major (CI-M). Students must designate CI-M subjects by petitioning the Subcommittee on the Communication Requirement. Each 21E and 21S program must include two CI-M subjects. Normally, students are expected to complete one CI-M from each area of study, usually chosen from the subjects designated as CI-M for the full major.

PLUS Departmental Program
Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

Restricted Electives
For the humanities component, one of the following (further details may be obtained from the descriptions of programs in specific fields and the relevant field office):

**Anthropology**
Nine subjects including 21A.100 or 21A.109, 21A.510, and 21A.512. An honors thesis may be done at the invitation and approval of faculty. 102–108

**Foreign Languages and Literatures (in French, German, or Spanish)**
Nine elective subjects, which may include a pre-thesis and thesis, subject to faculty approval. 81–102

**History**
Seven elective subjects, a pre-thesis tutorial, and a thesis. 81–102

**Literature**
Eight elective subjects (including two seminars and subjects in three historical periods or thematic complexes). 96

**Music**
Eight 12-unit subjects, including 21M.220, 21M.301, 21M.302, 21M.500, one year (two 6-unit subjects) of performance, and three electives: one in Western or World music (21M.230–289 or 21M.291–299); one in theory/composition (21M.300–399), and one in history/literature, theory/composition, or performance (two 6-unit terms of 21M.401–499), to be selected in consultation with the major advisor. 96

**Writing: Creative or Expository**
Seven subjects centered in creative or expository writing (one of these subjects is normally at the introductory level, one may be chosen from a related field), a pre-thesis tutorial, and a thesis. 96–102

**Writing: Science Writing or Technical Communication Studies**
Four subjects in writing (including 21W.777, 21W.778, 21W.792, and a subject in basic exposition), three subjects from related curricula (including, for Science Journalism, subjects in the history and social context of science/technology, or, for Technical Communication, 9.00, a subject in graphics and design, and a subject in the structure of business organizations), a pre-thesis tutorial, and a thesis. 90–102

**American Studies**\(^{(2)}\)
Seven elective subjects (including two in history and two in literature), a pre-thesis tutorial, and a thesis. Students may submit a request to the American Studies faculty advisor to substitute two classes in lieu of the pre-thesis and thesis. 81–102

**Ancient and Medieval Studies**\(^{(2)}\)
Seven elective subjects (should follow the general structure of the Ancient and Medieval Studies Minor Program), a pre-thesis tutorial, and a thesis. 81–102

**Comparative Media Studies**
Eight CMS subjects, including 21L.011 or CMS.100, one mid-tier subject (CMS.400, CMS.403, CMS.405, or CMS.407), one capstone subject (21L.706 or 21L.715), and five CMS electives. A pre-thesis tutorial (CMS.TH1) and thesis (CMS.TH2) may be substituted for one CMS elective. 81–102

**East Asian Studies**\(^{(2)}\)
Seven elective subjects (should follow the general structure of the East Asian Studies Minor program), a pre-thesis tutorial, and a thesis. 81–102

**Latin American Studies**\(^{(2)}\)
Introduction to Latin American Studies (21F.084J/ 17.55J/ 21A.224J) plus six elective subjects (including study in at least two disciplines and some work in Spanish or Portuguese language), a pre-thesis tutorial and a thesis. 81–102

**Psychology**\(^{(2)}\)
Nine elective subjects including 9.00 and approved by a faculty member in the field. 81–102

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\(^{(1)}\) General Institute Requirements (GIRs)
\(^{(2)}\) Electives designated as American Studies, Ancient and Medieval Studies, East Asian Studies, Latin American Studies, and Psychology are subject to special study requirements.

---

293 subjects 21.ThT to 21.URG
<table>
<thead>
<tr>
<th>Department</th>
<th>Units Required</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Humanities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russian Studies</td>
<td>81–102</td>
<td>Seven elective subjects (including Russian IV or equivalent), a pre-thesis tutorial, and a thesis.</td>
</tr>
<tr>
<td>Science, Technology, and Society (STS)</td>
<td>90–108</td>
<td>Eight subjects (including an STS HASS-D subject, STS.091, or STS.092), a pre-thesis tutorial, and a thesis.</td>
</tr>
<tr>
<td>Theater Arts</td>
<td>90–108</td>
<td>Eight subjects (including Script Analysis, Theater Practicum, and Stagecraft), a pre-thesis tutorial, and a thesis.</td>
</tr>
<tr>
<td>Women’s and Gender Studies</td>
<td>81–102</td>
<td>Seven subjects (including SP.401 Introduction to Women’s and Gender Studies), a pre-thesis tutorial, and a thesis. Students may submit a request to the Women’s and Gender Studies director to substitute two classes in lieu of the thesis and pre-thesis.</td>
</tr>
<tr>
<td><strong>And for the engineering/science component, one of the following:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For 21E</td>
<td>54–72</td>
<td>Six elective subjects restricted to one of the engineering curricula and approved by a faculty member in the field.</td>
</tr>
<tr>
<td>For 21S</td>
<td>54–72</td>
<td>Six elective subjects restricted to one of the science curricula and approved by a faculty member in the field.</td>
</tr>
<tr>
<td><strong>Departmental Program Units That Also Satisfy the GIRs</strong></td>
<td>(54–72)</td>
<td></td>
</tr>
<tr>
<td>Unrestricted Electives</td>
<td>54–103</td>
<td></td>
</tr>
<tr>
<td><strong>Total Units Beyond the GIRs Required for SB Degree</strong></td>
<td>180</td>
<td>No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.</td>
</tr>
</tbody>
</table>

**Notes on 21E and 21S**

(1) As a matter of general Course 21 policy, subjects used to meet the General Institute Science Requirement, the REST Requirement, and the Laboratory Requirement may not be included in the six-subject Engineering or Science component of 21E or 21S degrees. Only one subject being used to meet the distribution element of the Humanities, Arts, and Social Sciences Requirement may be counted toward the humanities component of these degree programs.

(2) American Studies, Ancient and Medieval Studies, East Asian Studies, Latin American Studies, Psychology, Russian Studies, Theater Arts, and Women’s and Gender Studies are also available as full majors by special arrangement with the Dean of the School of Humanities, Arts, and Social Sciences.

(3) Russian language subjects are not offered at MIT, but may be taken at Harvard University or Wellesley College through cross-registration.

(4) When possible, the subject satisfying the Institute Laboratory Requirement and one of the subjects satisfying the REST Requirement should be selected from this same curriculum, in addition to the regular requirement.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
The anthropology subjects described below are grouped within seven areas: Introductory, Social Anthropology, Technology in Cultural Context, Areal and Historical Studies, Advanced Undergraduate, Special Subjects and Topics, and Graduate Subjects Topics.

**INTRODUCTORY**

21A.100 Introduction to Anthropology
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 4

What kinds of wisdom do other ways of life offer our own? How do other perspectives on the world challenge our assumptions about life? These questions are addressed through the four fields of anthropology: biological, cultural, and linguistic anthropology, and archaeology. We examine family and kinship, religion, economics, politics, survival of indigenous groups, and Western influences from an anthropological perspective to gain appreciation for cultural and ethnic diversity.

C. Walley

21A.109 How Culture Works
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 4

Introduces diverse meanings and uses of the concept of culture with historical and contemporary examples from scholarship and popular media around the globe. Includes first-hand observations, synthesized histories and ethnographies, quantitative representations, and visual and fictionalized accounts of human experiences. Students conduct empirical research on cultural differences through the systematic observation of human interaction, employ methods of interpretative analysis, and practice convincing others of the accuracy of their findings.

M. Buyandelger, E. C. James

**SOCIAL ANTHROPOLOGY**

21A.212 Myth, Ritual, and Symbolism
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

How people make sense of their worlds symbolically through myth, ritual, metaphor, and cosmology. The structure of symbols, the natural and social elements they draw on, their social use, and the messages they convey. Students learn to record and analyze myth and ritual.

J. Howe

21A.215 Disease and Health: Culture, Society, and Ethics
Prereq: None
U (Spring)
3-0-9 HASS, CI-H

Examines how medicine is practiced cross-culturally, with particular emphasis on Western biomedicine. Analyzes medical practice as a cultural system, focusing on the human, as opposed to the biological, side of things. Also considers how people in different cultures think of disease, health, body, and mind. Enrollment limited.

J. Jackson

21A.216] Dilemmas in Biomedical Ethics: Playing God or Doing Good?
(Same subject as SP.622J)
Prereq: None
U (Fall)
3-0-9 HASS, CI-H

An introduction to the cross-cultural study of biomedical ethics. Examines moral foundations of the science and practice of western biomedicine through case studies of abortion, contraception, cloning, organ transplantation and other issues. Evaluates challenges that new medical technologies pose to the practice and availability of medical services around the globe, and to cross-cultural ideas of kinship and personhood. Discusses critiques of the biomedical tradition from anthropological, feminist, legal, religious, and cross-cultural theorists. Enrollment limited.

E. C. James

21A.217] Identity and Difference
(Same subject as SP.454J)
Prereq: None
U (Spring)
3-0-9 HASS, CI-H

Examines several theoretical perspectives on human identity and focuses on processes of creating categories of acceptable and deviant identities; how identities are formed, how behaviors are labelled, and how people enter deviant roles and worlds; and responses to differences and strategies for coping with these responses. Describes how identity and difference are inescapably linked. Enrollment limited.

J. Jackson

21A.218] Law and Society
(Same subject as 11.163J, 17.249J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS, CI-H

Studies legal reasoning, types of law and legal systems, and relationship of law to social class and social change. Emphasis on the profession and practice of law including legal education, stratification within the bar, and the politics of legal services. Investigation of emerging issues in the relationship between institutions of law and science. Enrollment limited.

S. Silbey

21A.113] The Supernatural in Music, Literature and Culture
(Same subject as 21L.013J, 21M.013J)
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 3, CI-H

See description under subject 21M.013J.

C. Shadle, M. Fuller, J. Howe

21A.114] Black Matters: Introduction to Black Studies
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 4, CI-H

See description under subject 21M.630J.

T. DeFrantz, S. Alexandre, C. Capozzola

21A.115J Disease and Health: Culture, Society, and Ethics
(Same subject as SP.454J)
Prereq: None
U (Spring)
3-0-9 HASS, CI-H

Examines several theoretical perspectives on human identity and focuses on processes of creating categories of acceptable and deviant identities; how identities are formed, how behaviors are labelled, and how people enter deviant roles and worlds; and responses to differences and strategies for coping with these responses. Describes how identity and difference are inescapably linked. Enrollment limited.

J. Jackson

21A.219] Law and Society
(Same subject as 11.163J, 17.249J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS, CI-H

Studies legal reasoning, types of law and legal systems, and relationship of law to social class and social change. Emphasis on the profession and practice of law including legal education, stratification within the bar, and the politics of legal services. Investigation of emerging issues in the relationship between institutions of law and science. Enrollment limited.

S. Silbey
21A.225J Violence, Human Rights, and Justice
(Same subject as SP.621J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS, CI-H
An examination of the problem of mass violence and oppression in the contemporary world, and of the concept of human rights as a defense against such abuse. Explores questions of cultural relativism, race, gender and ethnicity. Examines case studies from war crimes tribunals, truth commissions, anti-terrorism policies and other judicial attempts to redress state-sponsored wrongs. Considers whether the human rights framework effectively promotes the rule of law in modern societies. Students debate moral positions and address ideas of moral relativism. Enrollment limited.
E. C. James

21A.226 Ethnic and National Identity
Prereq: None
U (Fall)
3-0-9 HASS, CI-H
An introduction to the cross-cultural study of ethnic and national identity. Students explore the history of nationalism, focusing on ideologies about the nation-state, and look at the ways gender, religious and racial identities intersect with ethnic and national ones. Ethnic conflict is examined, along with the emergence of social movements based on identity, in particular indigenous rights movements and the ways culture can become highly politicized. Finally, students discuss the effects of globalization, migration, and transnational institutions. Enrollment limited.
J. Jackson

21A.232J Rethinking the Family, Sex, and Gender (New)
(Same subject as SP.429J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Cross-cultural case studies introduce students to the anthropological study of the social institutions and symbolic meanings of family, gender, and sexuality. Investigates the different forms families and households take and considers their social, emotional, and economic dynamics. Analyzes how various expectations for, and experiences of, family life are rooted in or challenged by particular conceptions of gender and sexuality. Addresses questions surrounding what it means to be a “man” or a “woman,” as well as a family member, in different social contexts.
H. Paxson

21A.235 American Dream: Exploring Class in the US
Prereq: None
U (Fall)
3-0-9 HASS
Americans have historically preferred to think of the United States in classless terms, as a land of economic opportunity equally open to all. Yet, social class remains a central fault line in the US. Subject explores the experiences and understandings of class among Americans positioned at different points along the US social spectrum. Considers a variety of classic frameworks for analyzing social class and uses memoirs, novels and ethnographies to gain a sense of how class is experienced in daily life and how it intersects with other forms of social difference such as race and gender.
C. Walley

21A.245J Power: Interpersonal, Organizational and Global Dimensions
(Same subject as 17.045J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Using examples from anthropology and sociology alongside classical and contemporary social theory, subject explores the nature of dominant and subordinate relationships, types of legitimate authority, and practices of resistance. Examines how we are influenced in subtle ways by the people around us, who makes controlling decisions in the family, how people get ahead at work, and whether democracies, in fact, reflect the will of the people.
S. Silbey

21A.252 How Cultures Remember
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Introduces scholarly debates about the socio-cultural practices through which individuals and societies create, sustain, recall, and erase memories. Emphasis is given to the history of knowledge, construction of memory, the role of authorities in shaping memory, and how societies decide on whose versions of memory are more “truthful” and “real.” Other topics include how memory works in the human brain, memory and trauma, amnesia, memory practices in the sciences, false memory, sites of memory, and the commodification of memory.
M. Buyandelger

21A.253 God, Violence, and Media
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Approaches to the socio-cultural study of religion. Provides conceptual tools for analyzing the resilience and diversity of religious experience in the face of large socio-economic and political change. Traces the connections between contemporary religious resurgence and violence, displacement, globalization, economic insecurity, and ethnic and national identity. Cases include Catholic conversion via mass media in the Philippines; a witchcraft epidemic in post-apartheid South Africa; underground Protestantism in the atheist Soviet Union; spiritual shopping in the United States.
M. Buyandelger

21A.265 Food and Culture
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Explores connections between what we eat and who we are through cross-cultural study of how personal identities and social groups are formed via food production, preparation, and consumption. Organized around critical discussion of what makes “good” food good (healthy, authentic, ethical, etc.). Uses anthropological and literary classics as well as recent writing and films on the politics of food and agriculture.
H. Paxson

21A.270 Anthropology through Speculative Fiction (New)
Prereq: None
U (Fall)
3-0-9 HASS
Examines how anthropology and speculative fiction (SF) each explore ideas about culture and society, technology, morality, and life in “other” worlds. Investigates this convergence of interest through analysis of SF in print, film, and other media. Covers traditional and contemporary anthropological themes, including first contact; gift exchange; gender, marriage, and kinship; law, morality, and cultural relativism; religion; race and embodiment; politics, violence, and war; medicine, healing, and consciousness; technology and environment.
E. C. James, S. Helmreich
TECHNOLOGY IN CULTURAL CONTEXT

21A.337 Documenting Culture
(Subject meets with CMS.917)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Surveys how and why people seek to capture life on film. Examines the motives of documentary and ethnographic filmmakers, including curiosity about exotic peoples, concern with documentary as a form of science, and an interest in capturing the truth about cultural life. Students view documentaries about people in the US and abroad, studying the relationship between film images and “reality,” tensions between art and observation, and the ethical relationship between filmmakers and those they film. Students taking the graduate version complete additional assignments.

C. Walley

21A.339J DV Lab: Documenting Science through Video and New Media (New)
(Same subject at STS.064J)
Prereq: None
U (Spring)
3-3-6 HASS

Introductory exploration of documentary film theory and production, focusing on documentaries about science, engineering, and related fields. Students engage in digital video production as well as social and media analysis of science documentaries. Readings drawn from social studies of science as well as from documentary film theory. Uses documentary video making as a tool to explore the worlds of science and engineering, as well as a tool for thinking analytically about media itself and the social worlds in which science is embedded. Class includes a lab component devoted to digital video production in addition to class time. Enrollment limited.

C. Walley, C. Boebel

21A.340J Technology and Culture
(Same subject as STS.075J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

Examines the intersections of technology, culture, and politics in a variety of social and historical settings ranging from 19th-century factories to 21st-century techno dance floors, from Victorian London to anything-goes Las Vegas. Discussions and readings organized around three questions: what cultural effects and risks follow from treating biology as technology; how computers have changed the way we think about ourselves and others; and how politics are built into our infrastructures. Explores the forces behind technological and cultural change; how technological and cultural artifacts are understood and used by different communities; and, whether, in what ways, and for whom technology has produced a better world.

K. Downes

(Same subject as 14.43J, 15.031J)
Prereq: 14.01 or permission of instructor
U (Spring)
4-0-8

See description under subject 15.031J.

D. Lessard, R. Schmalensee, S. Silbey

21A.342 Environmental Struggles
Prereq: None
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9 HASS

Offers an international perspective on the environment. Using environmental conflict to consider the stakes that groups in various parts of the world have in nature, while also exploring how ecological and social dynamics interact and change over time, subject considers such controversial environmental issues as: nuclear contamination in Eastern Europe; genetic bioprospecting in Mexico; toxic run-off in the rural US; the Bhopal accident in India; and the impact of population growth in the Third World.

C. Walley

21A.344J Drugs, Politics, and Culture
(Same subject as STS.062J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Examines the relationship between drugs, politics, and society in cross-cultural perspective; use of mind-altering and habit-forming substances by “traditional societies”; the development of a global trade in sugar, opium, and cocaine with the rise of capitalism; and the use and abuse of alcohol, LSD, and Prozac in the US. Finishes by looking at the war on drugs, shifting attitudes to tobacco, and by evaluating America’s drug laws.

Staff

21A.345 The Politics of International Development
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Offers an anthropological perspective on international development. Students consider development, not in policy or technical terms, but through its social and political dynamics and its impacts on daily life. Examines the various histories of, and meanings given to, international development as well as the social organization of aid agencies and projects. Follows examples of specific projects in various parts of the world. Examples: water projects for pastoralists in Africa, factory development in Southeast Asia, and international nature parks in Indonesia.

C. Walley

21A.348 Photography and Truth
(Subject meets with CMS.835)
Prereq: None
U (Spring)
3-0-9 HASS

Photographs in anthropology serve many purposes: as primary data, illustrations of words in a book, documentation for disappearing cultures, evidence of fieldwork, material objects for museum exhibitions, and even works of art. Topics include: the relationships between subject and treatment of image, between art and photography and ethnographic documentation, the role of a museum photograph and its caption, the social practice of “taking pictures” and a case study of photographing women in the Middle East and North Africa.

J. Howe

21A.355J The Anthropology of Biology
(Same subject as STS.060J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Applies the tools of anthropology to examine biology in the age of genomics, biotechnological enterprise, biodiversity conservation, pharmaceutical bioprospecting, and synthetic biology. Examine such social concerns such as bioterrorism, genetic modification, and cloning. Offers an anthropological inquiry into how the substances and explanations of biology—ecological, organismic, cellular, molecular, genetic, informatic—are changing. Examines such artifacts as cell lines, biodiversity databases, and artificial life models, and using primary sources in biology, social studies of the life sciences, and literary and cinematic materials, asks how we might an-
S. Helmreich

21A.360J The Anthropology of Sound
(Same subject as STS.065J)
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 HASS
Credit cannot also be received for CMS.407

Examines the ways humans experience sound and how perceptions and technologies of sound emerge from cultural, economic, and historical worlds. Consider how the sound/noise boundary has been imagined, created, and modeled across sociocultural and scientific contexts. Learn how environmental, linguistic, and musical sounds are construed cross-culturally as well as the rise of telephony, architectural acoustics, sound recording, and the globalized travel of these technologies. Questions of sound ownership, property, authorship, and copyright in the digital age are also addressed.
S. Helmreich

21A.370J Art, Craft, Science
(Same subject as STS.074J)
Prereq: None
U (Fall)
3-0-9 HASS

Examines how people learn, practice, and evaluate traditional and contemporary craft techniques. Social science theories of design, embodiment, apprenticeship learning, skill, labor, expertise, and tacit knowledge are used to explore distinctions among art, craft, and science. Also discusses the commoditization of craft into market goods, collectible art, and tourism industries. Ethnographic and historical case studies include textiles, Shaker furniture, glassblowing, quilting, cheesemaking, industrial design, home and professional cooking, factory and laboratory work, CAD/CAM. Demonstrations, optional field trips, and/or hands-on craft projects may be included.
S. Roosth

AREAL AND HISTORICAL STUDIES

21A.430J Introduction to Latin American Studies
(Same subject as 17.55J, 21F.084J)
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 4, CI-H
See description under subject 17.55J.
C. Lawson, M. Nobles

21A.470J Gender and Representation of Asian Women
(Same subject as SP.448J)
Prereq: None
U (Spring)
3-0-9 HASS

Explores some of the forces and mechanisms through which stereotypes are built and perpetuated. In particular, examines stereotypes associated with Asian women in colonial, nationalist, state-authoritarian, and global/diasporic narratives about gender and power. Students read ethnography, fiction, and history, and view films to examine the politics and circumstances that create and perpetuate the representation of Asian women as dragon ladies, lotus blossoms, despotic tyrants, desexualized servants, and docile subordinates. Students are introduced to debates about Orientalism, gender, and power.
M. Buyandelger

ADVANCED UNDERGRADUATE

21A.510 Seminar in Anthropological Theory
(21A.110)
Prereq: Permission of instructor
U (Fall)
3-0-9 HASS

Focuses on core issues and approaches in anthropological theory and method. Studies theoretical frameworks for the analysis and integration of material from other subjects in cultural anthropology. Reading and discussion of classics of anthropological theory and contemporary critiques. Students prepare and present analyses of texts. Preference to Anthropology majors and minors.
J. Jackson

21A.512 Seminar in Ethnography and Fieldwork
(21A.112)
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS

Introduction to ethnographic practices: the study of and communicating about culture. Sub-

SPECIAL SUBJECTS AND TOPICS

21A.650, 21A.651 Special Topics in Anthropology
Prereq: Any two subjects in Anthropology
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Topics in anthropology not included in other subjects. Students electing this subject must discuss the subject with the instructor and secure the approval of the Head of the Anthropology Program. HASS credit for Special Topics subjects awarded only by individual petitions to the Committee on Curriculum. Normal maximum is 6 units; to count toward HASS Requirement, 9 units are required. Exceptional 9- and 12-unit projects occasionally approved.
Consult Department Head

21A.660–21A.664 Special Seminars in Anthropology
Prereq: None
U (Fall, IAP, Spring)
3-0-9 HASS

Seminar for subjects taught outside the regularly-offered curriculum.
Staff

21A.ThT Anthropology Pre-Thesis Tutorial
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Students writing a thesis work with an advisor to develop research topics, review relevant research and scholarship, frame research questions, choose an appropriate methodology for data collection and analysis, and draft the introductory and methodology sections of their theses. Includes substantial practice in writing (with revision) and oral presentations.
Consult Department Head

21A.ThU Undergraduate Thesis in Anthropology
Prereq: 21A.ThT
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Completion of work on the senior major thesis under supervision of a faculty thesis advisor.
Includes oral presentation of thesis progress early in the term, assembling and revising the final text, and a final meeting with a committee of faculty evaluators to discuss the successes and limitations of the project.

*Staff*

**21A.UR Undergraduate Research**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

**21A.URG Undergraduate Research**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.

*Staff*

**GRADUATE SUBJECTS AND TOPICS**

**21A.750J Social Theory and Analysis**
(Same subject as STS.250J)
Prereq: None
G (Fall)
3-0-9

Major theorists and theoretical schools since the late 19th century. Marx, Weber, Durkheim, Bourdieu, Levi-Strauss, Geertz, Foucault, Gramsci, and others. Key terms, concepts, and debates.

*M. Fischer*

**21A.760J Qualitative Research Methods**
(Same subject as 15.349J, STS.401J)
Prereq: None
G (Spring)
3-6-3

Training in the design and practice of qualitative research. Organized around illustrative texts, class exercises, and student projects. Topics include the process of gaining access to and participating in the social worlds of others; techniques of observation, fieldnote-taking, researcher self-monitoring and reflection; methods of inductive analysis of qualitative data including conceptual coding, grounded theory, and narrative analysis. Discussion of research ethics, the politics of fieldwork, modes of validating researcher accounts, and styles of writing up qualitative field research.

*S. Silbey, E. C. James*

**21A.780 Representing Reality: Theories and Production of Documentary Film and Video (STS.451)**
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9

Explores theories and production of documentary film and video-making. Topics include how documentaries encapsulate or contest commonplace meanings of reality and truth in everyday life; how the historical use of visual technologies have alternately built upon and contested positivist scientific understandings; and how historical transformations in film and video technologies periodically restructure the nature of documentary filmmaking, reshaping understandings of everyday truth in the process. Assignments in written and production-oriented exercises. Enrollment limited.

_C. Walley, C. Boebel_

**21A.790J Ethics of Intervention: Anthropological Approaches**
(Same subject as 11.238J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

An historical and cross-cultural study of the logics and practices of intervention: the ways that individuals, institutions, and governments identify conditions of need or states of emergency within and across borders that require a response. Examines when a response is viewed as obligatory, when is it deemed unnecessary, and by whom; when the intercession is considered fulfilled; and the rationales or assumptions that are employed in assessing interventions. Theories of the state, globalization, and humanitarianism; power, policy, and institutions; gender, race, and ethnicity; and law, ethics, and morality are examined.

_E. C. James_

**21A.830J History and Anthropology of Medicine and Biology**
(Same subject as STS.330J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject STS.330J.

_D. Jones, S. Helmreich_

**21A.861 Methods for Graduate Research in the Social Sciences**
(Subject meets with 15.347)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Foundations of good empirical research in the social sciences. Introduction to the basic assumptions and underlying logic of both quantitative and qualitative methodologies. Explores a variety of approaches to research design, evaluates the products of empirical research, and practices several common techniques. Students develop a framework for their own research project.

_S. Silbey, A. McCants_

**21A.880J Environmental Conflict and Social Change**
(Same subject as STS.320J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Explores the complex interrelationships among humans and natural environments, focusing on non-western parts of the world in addition to Europe and the United States. Use of environmental conflict to draw attention to competing understandings and uses of “nature” as well as the local, national and transnational power relationships in which environmental interactions are embedded. In addition to utilizing a range of theoretical perspectives, subject draws upon a series of ethnographic case studies of environmental conflicts in various parts of the world.

_C. Walley_

**21A.882J Ethnography**
(Same subject as STS.360J)
Prereq: Permission of instructor; Coreq: 21A.750J
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

See description under subject STS.360J.

_M. Fischer_

**21A.998, 21A.999 Advanced Topics in Anthropology**
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit

Special studies or projects at an advanced level with an Anthropology faculty member.

_Consult Program Head_
## Bachelor of Science in Anthropology/Course 21A

### General Institute Requirements (GIRs) Subjects
- **Science Requirement**
  - Humanities, Arts, and Social Sciences Requirement [three subjects may be satisfied by subjects in the Departmental Program] 6
- **Restricted Electives in Science and Technology (REST) Requirement** 8
- **Laboratory Requirement** 2
- **Total GIR Subjects Required for SB Degree** 17

### Communication Requirement
The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

### PLUS Departmental Program Subjects
- **Required Subjects**
  - **Units**
  - **21A.100 Introduction to Anthropology**, 12, HASS-D 48
  - **21A.109 How Culture Works**, 12, HASS-D
  - **21A.510 Seminar in Anthropological Theory**, 12, HASS, CI-M *
  - **21A.512 Seminar in Ethnography and Fieldwork**, 12, HASS, CI-M *

- **Restricted Electives**
  - A coherent program of eight anthropology subjects which may include a pre-thesis tutorial and a thesis.
  - The decision to write a thesis is made in consultation between the student and advisor.

- **Total Units Beyond the GIRs Required for SB Degree**
  - **180**

### Notes
- *Prerequisites and corequisites are listed in the subject description.
- For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
The subjects listed below include language, literature, and cultural studies given in Chinese, French, German, Italian, Japanese, Spanish, and Studies in International Literatures and Cultures. A variety of literature subjects given in the original language as well as some given in English offer HASS Distribution (HASS-D) credit.

HASS-D Language Option: Because the Institute regards competence in foreign language as a fundamental value, students may substitute one language subject at level III or IV (i.e., 21F.103, 21F.104, 21F.109, 21F.110, 21F.303, 21F.304, 21F.403, 21F.404, 21F.503, 21F.504, 21F.703, or 21F.704) for one HASS-D subject. The two remaining HASS-Ds may be chosen from any two of the five HASS-D categories. Students selecting this language option may not choose a second distribution subject taught in the same foreign language or literature.

All first- and second-year foreign language subjects are open to graduate students for credit.

For subjects in English Language Studies, see 21F.211–21F.240.

STUDIES IN INTERNATIONAL LITERATURES AND CULTURES

Studies in International Literatures and Cultures make various modes of intercultural discourse available in English. Those subjects that deal with works from more than one nation give students the opportunity to do work in comparative studies. A significant number of subjects also allow students to study works from a single foreign country.

21F.011 Topics in Indian Popular Culture
Prereq: None
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9 HASS, CI-H
Can be repeated for credit
Overview of Indian popular culture over the last two decades, through a variety of material such as popular fiction, music, television and Bombay cinema. Explores major themes and their representations in relation to current social and political issues, elements of the formulaic masala movie, music and melodrama, ideas of nostalgia and incumbent change in youth culture, and questions of gender and sexuality in popular fiction. Taught in English. Enrollment limited.
A. Banerjee

21F.019 Communicating Across Cultures
(Subject meets with 21F.021)
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 1, CI-H
Examines a range of communication styles and techniques resulting from different cultural norms and traditions. Begins with a general theoretical framework and then moves into case studies. Topics include understanding the relationship between communication and culture, differences in verbal and non-verbal communication styles, barriers to intercultural communication, modes of specific cross-cultural communication activities (argumentation, negotiation, conflict resolution) and intercultural adjustment. Case studies explore specific ways of communicating in Asian and European cultures. Graduate students are expected to complete additional assignments. Taught in English. Enrollment limited.
J. Dunphy

21F.021 Communicating Across Cultures
(Subject meets with 21F.019)
Prereq: None
G (Spring)
3-0-9
See description under subject 21F.019.
J. Dunphy

21F.022J International Women’s Voices
(Subject meets with SP.461J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS-D, Category 1, CI-H
Introduces students to a variety of fictional works by contemporary women writers. Subject’s international perspective emphasizes the extent to which each author’s work reflects her distinct cultural heritage and to what extent, if any, we can identify a female voice that transcends national boundaries. A variety of interpretive perspectives, including sociohistorical, psychoanalytic, and feminist criticism is used to examine the texts. Authors include: Mariama Bâ, Isabel Allende, Anita Desai, Maxine Hong Kingston, Alifa Riyaat, Yang Jiang, Nawal Al-Saadawi, and Sawako Ariyoshi. Taught in English.
M. Resnick

21F.023 Women’s Voices: An International Perspective
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9
Introduces students to fictional works by contemporary women writers. Subject’s international perspective emphasizes the extent to which each author’s work reflects her distinct cultural heritage and to what extent, if any, we can identify a female voice that transcends national boundaries. Interpretive perspectives, including sociohistorical, psychoanalytic, and feminist criticism. Authors include: Mariama Bâ, Isabel Allende, Hong Kingston, Toni Morrison, Alifa Riyaat, Nawal Al-Saadawi, Yang Jiang, Anita Desai, and Sawako Ariyoshi. Taught in English.
M. Resnick

21F.024J The Linguistic Study of Bilingualism
(Same subject as 24.906J)
Prereq: 24.900
U (Fall)
3-0-9 HASS, CI-H
See description under subject 24.906J.
S. Flynn

21F.027J Visualizing Cultures
(Same subject as 21H.917J)
(Subject meets with 21F.590, CMS.874)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS, CI-H
Credit cannot also be received for 21F.590
Examines how visual images shape the identity of peoples and cultures. A prototype digital project looking at American and Japanese graphics depicting the opening of Japan to the outside

301 subjects 21F.011 to 21F.027J
world in the 1850s is used as a case study to introduce the conceptual and practical issues involved in visualizing cultures. Guest lecturers include professionals engaged in various aspects of collecting, analyzing, and presenting graphic images. Students create and present a project involving visualized cultures. Taught in English. 21F.590 is for students pursuing a minor in Japanese; students complete some assignments in Japanese. Enrollment limited. S. Miyagawa, J. Dower

21F.029 Topics in Asian American Literature
Prereq: None
U (Spring)
3-0-9 HASS
Can be repeated for credit
Close study of topics in the history and criticism of Asian American writing, focusing on a specific period or genre, a group of writers, a theme, or a critical or theoretical issue. Taught in English. E. Teng

21F.030 East Asian Culture: From Zen to Pop
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Examines traditional forms of East Asian culture (including literature, art, performance, food, and religion) as well as contemporary forms of popular culture (film, pop music, karaoke, and manga). Covers China, Japan, Korea, Taiwan, and Hong Kong, with an emphasis on China. Attention given to women’s culture. The influence and presence of Asian cultural expressions in the US are also considered. Use made of resources in the Boston area, including the MFA, the Children’s Museum, and the Sackler collection at Harvard. Taught in English. E. Teng

21F.035 Topics in Culture and Globalization
(Subject meets with 21F.037)
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS
Can be repeated for credit with permission of instructor
Scans existing debates about the interconnectedness of cultures and societies that are geographically wide apart, and explores how globalization impacts everyday life and larger institutional structures. Considers how to analyze the emergence of both common cosmopolitan cultures and new kinds of conflicts, and changes developing in religious, social and political movements related to globalization. Students taking the graduate version are expected to complete additional assignments. Taught in English.
I. Condry

21F.036 Advertising and Popular Culture: East Asian Perspectives
(Subject meets with 21F.190, CMS.888)
Prereq: None
U (Fall)
3-0-9 HASS
Credit cannot also be received for 21F.190
Examines modern advertising culture in East Asia (with a week devoted to India) with an emphasis on post-socialist China. Topics include the rise of transnational advertising agencies in East Asia since the 1980s; advertising and identity formation; the production of brand culture and its impact on youth culture; music marketing; the new paradigm of neo neo-tribes; media and advertising, and mobile culture and branding. Case studies of famous advertising campaigns for beer and beverage brands, clothing brands, and Internet portal brands. Lab sessions on how to brand your own imaginary product step by step. View award-winning ads presented at the Asia/Pacific Advertising Festivals and Chinese television commercials. Graduated credits offered through CMS 888. Taught in English. 21F.190 is for students pursuing a minor in Chinese; students complete assignments in Chinese.
J. Wang

21F.037 Topics in Culture and Globalization
(Subject meets with 21F.035)
Prereq: Permission of instructor
G (Spring)
3-0-6
Can be repeated for credit
See description under subject 21F.035.
I. Condry

21F.038 The Cultural Politics of Contemporary China
Prereq: None
U (Spring)
3-0-9 HASS
Introduction to the study of modern and contemporary China, including Taiwan, Hong Kong, and the Chinese diaspora. Themes include debates over “Cultural China” and “Chineseness”; state and (flexible) citizenship, and contemporary Mao Zedong fever; gender and the politics of pornography; the consumer revolution, leisure, and popular culture; ethnic minorities, globalization, and local responses. Students watch documentaries and feature films, and read essays that highlight dramatic moments in the transformation of Chinese societies in East Asia.
A. Banerjee

21F.039 Japanese Popular Culture
(Subject meets with 21F.591)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Credit cannot also be received for 21F.591
Examines Japanese popular culture as a way of understanding the changing character of media, capitalism, fan communities and cultural differences. Topics include manga (comic books), hip-hop and other popular music in Japan, anime (Japanese animated films) and feature films, sports (sumo, soccer, baseball), and online communication. Emphasis on contemporary popular culture and theories of gender, sexuality, race, and the workings of power in global culture industries. Several films screened outside of regular class meeting times. Taught in English. 21F.591 is for students pursuing a minor in Japanese; students complete some assignments in Japanese.
I. Condry

21F.040 A Passage to India: Introduction to Modern Indian Culture and Society
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Introduction to Indian culture through films, short-stories, novels, essays, newspaper articles. Examines some major social and political controversies of contemporary India through discussions centered on India’s history, politics and religion. Focuses on issues such as ethnic tension and terrorism, poverty and inequality, caste conflict, the missing women, and the effects of globalization on popular and folk cultures. Particular emphasis on the IT revolution, outsourcing, the new global India and the enormous regional and subcultural differences. Taught in English.
A. Banerjee
studies to examine the experiences of Asian Americans in US society. Covers the first wave of Asian immigration in the 19th century, the rise of anti-Asian movements, the experiences of Asian Americans during WWII, the emergence of the Asian American movement in the 1960s, and the new wave of “post-1965” Asian immigration. Examines the role these historical experiences played in the formation of Asian American ethnicity, and explores how these experiences informed Asian American literature and culture. Addresses key societal issues such as racial stereotyping, media racism, affirmative action issues, the glass ceiling, the “model minority” syndrome, and anti-Asian harassment or violence. Taught in English.

E. Teng

21F.044 Traditional Chinese Literature: Poetry, Fiction, and Drama
Prereq: None
U (Fall)
3-0-9 HASS

Introduction to some of the major genres of traditional Chinese poetry, fiction, and drama. Intended to give students a basic understanding of the central features of traditional Chinese literary genres, as well as to introduce students to the classic works of the Chinese literary tradition. Works read include Journey to the West, Outlaws of the Margin, Dream of the Red Chamber, and the poetry of the major Tang dynasty poets. Literature read in translation. Taught in English.

E. Teng

21F.046 Modern Chinese Fiction and Cinema
(Subject meets with 21F.192)
Prereq: None
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9 HASS, CI-H

Credit cannot also be received for 21F.192

Covers major works of Chinese fiction and film, from mainland China, Taiwan, and Hong Kong. Focusing on the modern period, subject examines how Chinese intellectuals, writers, and filmmakers have used artistic works to critically explore major issues in modern Chinese culture and society. Literature read in translation. Taught in English. 21F.192 is for students pursuing a minor in Chinese. Enrollment limited.

J. Wang

21F.051 Topics in French Film
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
2-2-8 HASS
Can be repeated for credit with permission of instructor

Close study of a topic that relates to the art and history of the French cinema and that focuses on a specific director, movement, theme, critical or theoretical issue, analytic approach, etc. Films shown with English subtitles. Taught in English.

E. B. Turk

21F.052 French Film Classics
Prereq: None
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
2-2-8 HASS

History and aesthetics of French cinema from the advent of sound to present-day. Treats films in the context of technical processes, the art of narration, directorial style, role of the scriptwriter, the development of schools and movements, the impact of political events and ideologies, and the relation between French and other national cinemas. Films shown with English subtitles. Taught in English.

E. B. Turk

21F.055 Media in Weimar and Nazi Germany
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
2-2-8 HASS, CI-H

Debates over national and media identity in Weimar and Nazi Germany. Production and use of media under extreme political and social conditions with a focus on films (such as Nosferatu, Berlin, M, and Triumph des Willens) and other media. Media approached as both texts and systems. Considers the legacy of the period, in terms of stylistic influence (e.g. film noir), techniques of persuasion, and media’s relationship to social and economic conditions. Taught in English. Enrollment limited.

W. Uricchio

21F.056 Visual Histories: German Cinema 1945 to Present
(Subject meets with 21F.420)
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
2-2-8 HASS, CI-H

Studies the history, aesthetics, and cultural contexts of German film since the end of World War II. Explores films of New German Cinema by Fassbinder, Wenders, Herzog, and others; and investigates the film tradition of the GDR and the “internationalization” of German cinema since the 1980s. Special thematic focus on the representation of history in film. Films shown with English subtitles. Taught in English. Enrollment limited.

K. Fendt

21F.059 Paradigms of European Thought and Culture
Prereq: None
Acad Year 2009–2010: U (Spring)
3-0-9 HASS-D, Category 2, CI-H

Subject surveys the main currents of European cultural and intellectual history in the modern period. Introduces a set of ideas and arguments that have played a formative role in European culture, and acquaints students with exemplars of critical thought. Readings begin with the Protestant Reformation and move through the French Revolution up to the post-WWII period. Figures to be considered include Luther, Descartes, Kant, Hegel, Rousseau, Smith, Marx, Freud, Beauvoir, and Foucault. Class discussions set these texts into the context of European culture. Topics to be considered are artworks by Goya, David, and Duchamp; the architecture of Schinkel; the music of Bach; and the literature of Goethe. Taught in English.

T. Nolden

21F.063 Anime: Transnational Media and Culture
(Subject meets with 21F.596)
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 HASS

Explores anime (Japanese animated films and TV shows) as a study in flows among media and cultures. Discusses Japan’s substantial share of the TV cartoon market and the reasons for anime’s worldwide success. Focuses on cultural production and the ways anime cultures are created through the interactive efforts of studios, sponsors, fans, broadcasters and distributors. Uses anime scholarship and media examples as a means to examine leading theories in media and cultural studies, gender and sexuality, technology and identity, and post-industrial globalization. Taught in English. 21F.596 is for students pursuing a minor in Japanese; students complete some assignments in Japanese.

I. Condry
21F.064 Introduction to Japanese Culture
(Subject meets with 21F.592)
Prereq: None
U (Fall, Spring)
3-0-9 HASS, D, Category 4, CI-H
Credit cannot also be received for 21F.592
Examines the major aesthetic, social, and political elements which have shaped modern Japanese culture and society. Readings on contemporary Japan and historical evolution of the culture are coordinated with study of literary texts, film, and art, along with an analysis of everyday life and leisure activities. Taught in English. 21F.592 is for students pursuing a minor in Japanese; students complete some assignments in Japanese.
I. Condry

21F.065 Japanese Literature and Cinema
(Subject meets with 21F.593)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS, CI-H
Credit cannot also be received for 21F.593
Surveys both cinematic and literary representations of diverse eras and aspects of Japanese culture such as the classical era, the samurai age, wartime Japan and the atomic bombings, social change in the postwar period, and the appropriation of foreign cultural themes, with an emphasis on the modern period. Directors include Akira Kurosawa and Hiroshi Teshigahara. Authors include Kobo Abe and Yukio Mishima. Films shown with subtitles in English. Taught in English. 21F.593 is for students pursuing a minor in Japanese. Enrollment limited.
I. Condry

21F.069J Race and Gender in Asian America
(Same subject as SP.603J, 21H.153J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
An interdisciplinary examination of the intersection of race and gender in Asian American texts (literary, historical, cinematic) from the mid-19th century to the present. Topics include media images of Asian American men and women, feminism and gender roles, and interracial romance. Writers include Maxine Hong Kingston, David Henry Hwang, Chang-rae Lee, Jessica Hagedorn, and Shirley Lim. Filmmakers include Mira Nair, Ang Lee, Wayne Wang, and Gurinder Chadha. Taught in English.
E. Teng

21F.076 Globalization: The Good, the Bad and the In-Between
U (Fall)
3-0-6 HASS, D, Category 4, CI-H
Examines the cultural paradoxes of contemporary globalization. Studies the cultural, linguistic, social and political impact of globalization across international borders and on specific language communities. Students analyze contending definitions of globalization and principal agents of change, and why some of them engender backlash; learn to distinguish what is considered new, hybrid, and traditional; identify the agents, costs and benefits of global networks; and explore how world citizens preserve cultural specificity. Students also develop cultural literacy through study of second language and culture, research, development of virtual materials, and interactions with MIT’s international students. Student cannot receive credit without simultaneous completion of a 9-unit language subject. Preference to freshmen.
M. Resnick, P. Tang

21F.080 Masterpieces of Hispanic Culture
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS, CI-H
Subject studies major works of Hispanic literature, film, and art, including the Poem of the Cid, Cervantes’ Don Quixote, García Márquez’s One Hundred Years of Solitude, and short stories by Borges, as well as films by Buñuel and paintings by Velázquez. Students trace development of diverse Hispanic cultures both in Spain and the Americas, through a thematic focus on honor codes, gender construction, class and caste hierarchies, and the historically-based problem of artistic representation. Taught in English. Enrollment limited.
E. Garrels

21F.084J Introduction to Latin American Studies
(Same subject as 17.55J, 21F.036, 21F.038, 21F.043J, 21F.044, 21F.046, 21F.069J, and 21F.076)
U (Fall)
3-0-9 HASS, D, Category 4, CI-H
An interdisciplinary introduction to Latin America, with emphasis on the modern period. For students pursuing a minor in Latin American Studies, with or without a subject in another field. Enrollment limited.
E. Teng

21F.098J Working in a Global Economy
(Subject meets with 17.199J)
Prereq: Permission of instructor
U (Fall)
3-0-9 HASS, CI-H
See description under subject 17.199J.
S. Berger, S. Sferza

21F.099J Independent International Research Project
(Subject meets with 17.921J)
Prereq: Permission of instructor
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
See description under subject 17.921J.
S. Berger

CHINESE

The subjects listed below include language, literature, and cultural studies subjects given in Chinese. Chinese language subjects are divided into ‘regular’ and ‘streamlined’. Typically, streamlined subjects are for students who have some conversational ability from growing up in a Chinese-speaking environment, but who have very little writing or reading ability. Students with a strong background in regional languages, such as Cantonese or Hokkien, are also encouraged to take streamlined subjects, but if in doubt, should consult the coordinator of the Chinese program. The 9-unit Globalization subjects cover the same material as their 12-unit counterparts, but they may only be taken in conjunction with 21F.076.

For Chinese Literature and Culture subjects offered in English, see 21F.029, 21F.030, 21F.036, 21F.038, 21F.043J, 21F.044, 21F.046, and 21F.069J.

Undergraduate Language Subjects

21F.101 Chinese I (Regular)
(Subject meets with 21F.151, 21F.171)
Prereq: None
U (Fall)
4-0-8 HASS
Introduction to modern standard Chinese (Mandarin) with emphasis on developing conversational skills by using fundamental grammatical patterns and vocabulary in functional and culturally suitable contexts. Basic reading and
writing are also taught. For graduate credit, see
21F.151.
J. Zhang

21F.171 Chinese I (Regular)—Globalization
(Subject meets with 21F.101, 21F.151)
Prereq: None. Coreq: 21F.076
U (Fall)
4-0-5 HASS

In conjunction with 21F.076, covers same material as 21F.101. See description under 21F.101. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.
J. Zhang

21F.102 Chinese II (Regular)
(Subject meets with 21F.152)
Prereq: 21F.101, 21F.171, or permission of instructor
U (Spring)
4-0-8 HASS

Continuation of 21F.101. For full description, see 21F.101. For graduate credit see 21F.152.
J. Zhang, M. Liang

21F.103 Chinese III (Regular)
(Subject meets with 21F.173)
Prereq: 21F.102 or permission of instructor
U (Fall)
4-0-8 HASS-D Language Option

Continuing instruction in spoken and written Chinese, with particular emphasis on consolidating basic conversational skills and improving reading confidence and depth. Lab work required.
T. Chen, M. Liang

21F.173 Chinese III (Regular)—Globalization
(Subject meets with 21F.103)
Prereq: 21F.102 or permission of instructor;
Coreq: 21F.076
U (Fall)
4-0-5 HASS

In conjunction with 21F.076, covers same material as 21F.103. See description under 21F.103. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.
T. Chen, M. Liang

21F.104 Chinese IV (Regular)
Prereq: 21F.103, 21F.173, or permission of instructor
U (Spring)
4-0-8 HASS-D Language Option

Continuation of 21F.103. For full description, see 21F.103.
T. Chen

21F.105 Chinese V (Regular): Discovering Chinese Cultures and Societies
(Subject meets with 21F.175)
Prereq: 21F.104 or permission of instructor
U (Fall)
3-0-9 HASS

Students develop more sophisticated conversational and reading skills by combining traditional textbook material with their own explorations of Chinese speaking societies, using the human, literary, and electronic resources available at MIT and in the Boston area.
T. Chen

21F.175 Chinese V (Regular)—Globalization
(Subject meets with 21F.105)
Prereq: 21F.104 or permission of instructor;
Coreq: 21F.076
U (Fall)
3-0-6 HASS

In conjunction with 21F.076, covers same material as 21F.105. See description under 21F.105. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.
M. Liang

21F.106 Chinese VI (Regular): Discovering Chinese Cultures and Societies
Prereq: 21F.105, 21F.175, or permission of instructor
U (Spring)
3-0-9 HASS

Continuation of 21F.105. For full description see 21F.105.
J. Zhang

Undergraduate Language Subjects—Streamlined

21F.107 Chinese I (Streamlined)
(Subject meets with 21F.157, 21F.181)
Prereq: Placement test and permission of instructor
U (Fall)
3-0-9 HASS

The first term streamlined sequence. Designed for students who have conversational skills (typically gained from growing up in a Chinese speaking environment) without a corresponding level of literacy. For graduate credit see 21F.157.
M. Liang

21F.181 Chinese I (Streamlined)—Globalization
(Subject meets with 21F.107, 21F.157)
Prereq: Placement test and permission of instructor;
Coreq: 21F.076
U (Fall)
3-0-6 HASS

In conjunction with 21F.076, covers same material as 21F.107. See description under 21F.107. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.
M. Liang

21F.108 Chinese II (Streamlined)
(Subject meets with 21F.158)
Prereq: 21F.107 or 21F.181; or placement test and permission of instructor
U (Spring)
3-0-9 HASS

The second term streamlined sequence; continuation of 21F.107. The streamlined sequence is designed for students who have conversational skills (typically gained from growing up in a Chinese speaking environment) without a corresponding level of literacy. For graduate credit see 21F.158.
M. Liang

21F.109 Chinese III (Streamlined)
(Subject meets with 21F.183)
Prereq: 21F.108; or placement test and permission of instructor
U (Fall)
3-0-9 HASS-D Language Option

Intermediate level subject in streamlined sequence. Designed for students who have conversational skills (typically gained from growing up in a Chinese speaking environment) without a corresponding level of literacy. Consolidates conversation skills, improves reading confidence and broadens composition style.
J. Zhang
21F.183 Chinese III (Streamlined)—Globalization
(Subject meets with 21F.109)
Prereq: Placement test and permission of instructor; Coreq: 21F.076
U (Fall)
3-0-6 HASS

In conjunction with 21F.076, covers same material as 21F.109. See description under 21F.109. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076. Restricted to concurrently registered students of 21F.076.

X. Zhang

21F.110 Chinese IV (Streamlined)
Prereq: 21F.109 or 21F.183; or placement test and permission of instructor
U (Spring)
3-0-9 HASS-D Language Option

Intermediate level subject in streamlined sequence; continuation of 21F.109. Designed for students who have conversational skills (typically gained from growing up in a Chinese speaking environment) without a corresponding level of literacy. Consolidates conversation skills, improves reading confidence and broadens composition style.

T. Chen

21F.113 Chinese V (Streamlined)
(Subject meets with 21F.185)
Prereq: 21F.110; or placement test and permission of instructor
U (Fall)
3-0-9 HASS

Advanced level subject in streamlined sequence. Designed for students who have conversational skills (typically gained from growing up in a Chinese speaking environment) without a corresponding level of literacy. Students conduct their own explorations of modern China using online and print materials, as well as interviews with Chinese in the Boston area.

X. Zhang

21F.185 Chinese V (Streamlined)—Globalization
(Subject meets with 21F.113)
Prereq: 21F.110 or placement test and permission of instructor; Coreq: 21F.076
U (Fall)
3-0-6 HASS

In conjunction with 21F.076, covers same material as 21F.113. See description under 21F.113. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.

X. Zhang

Graduate Language Subjects

21F.151 Chinese I (Regular)
(Subject meets with 21F.101, 21F.171)
Prereq: None
G (Fall)
4-0-5
See description under subject 21F.101.

J. Zhang

21F.152 Chinese II (Regular)
(Subject meets with 21F.102)
Prereq: 21F.151 or permission of instructor
G (Spring)
4-0-5
See description under subject 21F.102.

J. Zhang, M. Liang

21F.157 Chinese I (Streamlined)
(Subject meets with 21F.107, 21F.181)
Prereq: Placement test and permission of instructor
G (Fall)
3-0-6
See description under subject 21F.107.

M. Liang

21F.158 Chinese II (Streamlined)
(Subject meets with 21F.108)
Prereq: 21F.157; or placement test and permission of instructor
G (Spring)
3-0-6
See description under subject 21F.108.

M. Liang

Chinese Language Option Subjects

21F.190 Advertising and Popular Culture: East Asian Perspectives
(Subject meets with 21F.036, CMS.888)
Prereq: None
U (Fall)
3-0-10 HASS, CI-H

Acad Year 2010–2011: Not offered
Acad Year 2009–2010: U (Spring)
Prereq: None
Credit cannot also be received for 21F.046

Covers major works of Chinese fiction and film, from mainland China, Taiwan, and Hong Kong. Focusing on the modern period, subject examines how Chinese intellectuals, writers, and filmmakers have used artistic works to critically explore major issues in modern Chinese culture and society. Literature read in translation. Taught in English. For students pursuing a minor in Chinese; students complete assignments in Chinese.

I. Chapman

21F.191 Smashing the Iron Rice Bowl: Chinese East Asia
(Subject meets with 21H.560)
Prereq: None
U (Fall)
2-0-8 HASS
Credit cannot also be received for 21H.560

Examines the experiences of ordinary Chinese people as they lived through tumultuous change in the 20th century. Class discussion focuses on personal memoirs and films. Includes comparisons between the People’s Republic of China, Taiwan, and Hong Kong. For students pursuing a minor in Chinese; students complete assignments in Chinese.

J. Wang

21F.192 Modern Chinese Fiction and Cinema
(Subject meets with 21F.046)
Prereq: None
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-10 HASS, CI-H
Credit cannot also be received for 21F.046

Examines modern advertising culture in East Asia (with a week devoted to India) with an emphasis on post-socialist China. Topics include the rise of transnational advertising agencies in East Asia since the 1980s; advertising and identity formation; the production of brand culture and its impact on youth culture; music marketing; the new paradigm of neo neo-tribes; media and advertising, and mobile culture and branding. Case studies of famous advertising campaigns for beer and beverage brands, clothing brands, and Internet portal brands. Lab sessions on how to brand your own imaginary product step by step. View award-winning ads presented at the Asia/Pacific Advertising Festivals and Chinese television commercials. Graduate credit offered through CMS 888. Taught in English. For students pursuing a minor in Chinese.

J. Wang
**ENGLISH LANGUAGE STUDIES (ELS)**

**Undergraduate Subjects**

21F.218 Workshop in Strategies for Effective Teaching (ELS)
(Subject meets with 21F.217)
Prereq: None
U (IAP)
1-0-2
See description under subject 21F.217.
A. C. Kemp

21F.220 Workshop in Written Expression (ELS)
(Subject meets with 21F.219)
Prereq: Placement test and permission of instructor
U (Fall, Spring)
3-0-9 HASS
Can be repeated for credit
See description under subject 21F.219.
Fall: P. Brennecke  
Spring: A. C. Kemp

21F.222 Expository Writing for Bilingual Students
Prereq: Placement test and permission of instructor
U (Fall, Spring)
3-0-9 HASS, CI-HW
Can be repeated for credit
Formulating, organizing, and presenting ideas clearly in writing. Reviews basic principles of rhetoric. Focuses on development of a topic, thesis, choice of appropriate vocabulary, and sentence structure to achieve purpose. Develops idiomatic prose style. Gives attention to grammar and vocabulary usage. Special focus on strengthening skills of bilingual students.
Undergraduates only. Enrollment limited.
Fall: A. C. Kemp, G. Lockwood  
Spring: G. Lockwood

21F.224 Listening, Speaking, and Pronunciation (ELS)
(Subject meets with 21F.223)
Prereq: Placement test and permission of instructor
U (Fall, Spring)
3-3-6 HASS
Can be repeated for credit
Designed for high intermediate ELS students who need to develop better listening comprehension and oral skills. The workshop involves short speaking and listening assignments with extensive exercises in accurate comprehension, pronunciation, stress and intonation, and expression of ideas.
Fall: P. Brennecke, A. C. Kemp, G. Lockwood  
Spring: A. C. Kemp

21F.225 Advanced Workshop in Writing for Science and Engineering (ELS)
(Subject meets with 21F.226)
Prereq: Placement test and permission of instructor
G (Fall, Spring)
3-0-9
Can be repeated for credit
Analysis and practice of various forms of scientific and technical writing, from memos to journal articles. Strategies for conveying technical information to specialist and non-specialist audiences. Comparable to 21W.780, but methods designed to deal with special problems of advanced ELS or bilingual students. The goal of the workshop is to develop effective writing skills for academic and professional contexts. Models, materials, topics and assignments vary from term to term. Listeners are not allowed.
Fall: J. Dunphy  
Spring: A. C. Kemp

21F.226 Advanced Workshop in Writing for Science and Engineering (ELS)
(Subject meets with 21F.225)
Prereq: Placement test and permission of instructor
U (Fall, Spring)
3-0-9 HASS, CI-H
Can be repeated for credit
See description under subject 21F.225.
J. Dunphy

21F.228 Advanced Workshop in Writing for Social Sciences and Architecture (ELS)
(Subject meets with 21F.227)
Prereq: Placement test and permission of instructor
U (Spring)
3-0-9 J HASS, CI-H
Can be repeated for credit with permission of instructor
See description under subject 21F.227.
P. Brennecke

21F.233 Advanced Speaking and Critical Listening Skills (ELS)
(Subject meets with 21F.232)
Prereq: Placement test and permission of instructor
U (Fall, Spring)
3-3-6 HASS
Can be repeated for credit with permission of instructor
See description under subject 21F.232.
Fall: J. Dunphy  
Spring: P. Brennecke

21F.219 Workshop in Written Expression (ELS)
(Subject meets with 21F.220)
Prereq: Placement test and permission of instructor
G (Fall, Spring)
3-0-9
Can be repeated for credit
Writing module for high intermediate ELS students who wish to review and practice accurate grammar, effective sentence and paragraph structure, punctuation, and word choice. Short weekly writing assignments with extensive editing required.
Fall: P. Brennecke  
Spring: A. C. Kemp

**Graduate Subjects**

21F.217 Workshop in Strategies for Effective Teaching (ELS)
(Subject meets with 21F.218)
Prereq: None
G (IAP)
1-0-2
A mini-module for international teaching assistants. Covers special problems in teaching when English is a second language and the US a second culture. Videotaping of practice sessions for feedback. Individualized programs to meet different needs. Graduate TAs have priority.
A. C. Kemp

21F.219 Workshop in Written Expression (ELS)
(Subject meets with 21F.220)
Prereq: Placement test and permission of instructor
G (Fall, Spring)
3-0-9
Can be repeated for credit
Writing module for high intermediate ELS students who wish to review and practice accurate grammar, effective sentence and paragraph structure, punctuation, and word choice. Short weekly writing assignments with extensive editing required.
Fall: P. Brennecke  
Spring: A. C. Kemp

21F.224 Listening, Speaking, and Pronunciation (ELS)
(Subject meets with 21F.223)
Prereq: Placement test and permission of instructor
G (Fall, Spring)
3-0-9
Can be repeated for credit
Designed for high intermediate ELS students who need to develop better listening comprehension and oral skills. The workshop involves short speaking and listening assignments with extensive exercises in accurate comprehension, pronunciation, stress and intonation, and expression of ideas.
Fall: P. Brennecke, A. C. Kemp, G. Lockwood  
Spring: A. C. Kemp

21F.225 Advanced Workshop in Writing for Science and Engineering (ELS)
(Subject meets with 21F.226)
Prereq: Placement test and permission of instructor
G (Fall, Spring)
3-0-9
Can be repeated for credit
Analysis and practice of various forms of scientific and technical writing, from memos to journal articles. Strategies for conveying technical information to specialist and non-specialist audiences. Comparable to 21W.780, but methods designed to deal with special problems of advanced ELS or bilingual students. The goal of the workshop is to develop effective writing skills for academic and professional contexts. Models, materials, topics and assignments vary from term to term. Listeners are not allowed.
Enrollment limited.
J. Dunphy
All subjects listed below are taught in French. The indication of prerequisites for specific French offerings does not apply to students who have already accomplished the equivalent work. For further placement advice, consult one of the field advisors in French. The 9-unit Globalization subjects cover the same material as their 12-unit counterparts, but they may only be taken in conjunction with 21F.076.

For French Literature and Culture subjects offered in English, see 21F.051 and 21F.052.

### Fundamental Language Subjects

**21F.301 French I**  
(Subject meets with 21F.351, 21F.371)  
Prereq: None  
U (Fall, IAP, Spring)  
4-0-8 HASS  
Introduction to the French language and culture with emphasis on the acquisition of vocabulary and grammatical concepts through active communication. Conducted entirely in French. Exposure to the language via a variety of authentic sources such as the Internet, video and printed materials which help develop cultural awareness as well as linguistic proficiency. Coordinated language lab program. For graduate credit see 21F.351.  
Fall: J. Sadock, L. Rezvani  
Spring: S. Levet

**21F.371 French I—Globalization**  
(Subject meets with 21F.301, 21F.351)  
Prereq: None. Coreq: 21F.076  
U (Fall)  
4-0-5 HASS  
In conjunction with 21F.076, covers same material as 21F.301. See description under 21F.301. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.  
J. Sadock, L. Rezvani

**21F.302 French II**  
(Subject meets with 21F.352, 21F.372)  
Prereq: 21F.301, 21F.371, or permission of instructor  
U (Fall, Spring)  
4-0-8 HASS  
Continuation of introductory course to the French language and culture with emphasis on acquisition of vocabulary and grammatical concepts through active communication. Conducted entirely in French. Exposure to the language via a variety of authentic sources such as the Internet, audio, video and printed materials which help develop cultural awareness as well as linguistic proficiency. Coordinated language lab. For graduate credit see 21F.352.  
C. Culot

**21F.372 French II—Globalization**  
(Subject meets with 21F.302, 21F.352)  
Prereq: 21F.301 or permission of instructor; Coreq: 21F.076  
U (Fall)  
4-0-5 HASS-D Language Option  
In conjunction with 21F.076, covers same material as 21F.302. See description under 21F.302. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.  
C. Culot

**21F.303 French III**  
(Subject meets with 21F.373)  
Prereq: 21F.302, 21F.372, or permission of instructor  
U (Fall, Spring)  
4-0-8 HASS-D Language Option  
Third subject in the French language sequence, with focus on intercultural understanding. Students participate in an online exchange with French students, and compare with their partners a variety of materials such as intercultural questionnaires, surveys, films, newspapers and visuals. The work on language is based on the authentic vocabulary, grammar and discourse generated during the online exchanges.  
Fall: S. Levet  
Spring: S. Levet, G. Furstenberg

**21F.373 French III—Globalization**  
(Subject meets with 21F.303)  
Prereq: 21F.302 or permission of instructor; Coreq: 21F.076  
U (Fall)  
4-0-5 HASS  
In conjunction with 21F.076, covers same material as 21F.303. See description under 21F.303. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.  
S. Levet

**21F.304 French IV**  
(Subject meets with 21F.374)  
Prereq: 21F.303, 21F.373, or permission of instructor  
U (Fall, Spring)  
4-0-8 HASS-D Language Option  
Contemporary France in relation to the Francoophone world. Current materials ranging from...
literary texts, films, digitized video interviews, the Internet and CD-ROMs. Further development of linguistic skills, for improving the overall quality of writing and oral fluency. Final subject in the French language sequence before taking intermediate subjects in French literature and culture.

J. Sadock

21F.374 French IV—Globalization
(Subject meets with 21F.304)
Prereq: 21F.303 or permission of instructor;
Coreq: 21F.076
U (Fall)
4-0-5 HASS

In conjunction with 21F.076, covers same material as 21F.304. See description under 21F.304. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.

J. Sadock

21F.306 French: Communication Intensive I
Prereq: Permission of instructor
U (Fall, Spring)
3-0-0

21F.307 French: Communication Intensive II
Prereq: Permission of instructor
U (Fall, Spring)
3-0-0


Staff

Advanced Subjects in Language, Literature, and Culture

These subjects (21F.308—21F.315) are designed for students who have completed French IV or its equivalent. They serve as a transition between language study and more advanced subjects in literature and cultures. Although each subject has a different emphasis, all provide students with additional practice in reading, speaking, and writing.

Students may take several subjects from these offerings. Native speakers of French who have studied French literature at a high-school level must seek the instructor’s approval for admission to any of these subjects.

21F.308 Writing (Like the) French
Prereq: 21F.304, 21F.374, or permission of instructor
U (Fall)
3-0-9 HASS

For students who wish to continue with language study before taking upper-level subjects in literature or culture. Emphasis on development of reading and writing skills, review of the basic concepts of French grammar, and acquisition of precise vocabulary through the use of printed materials, short stories, and poems. Taught in French.

C. Culot

21F.310 French Conversation: Intensive Practice
Prereq: 21F.304, 21F.374, or permission of instructor
U (Spring)
3-0-9 HASS

Contemporary cultural phenomena and political debates in France and the Francophone world. Training in oral expression including communication skills, fluency, idiomatic French and pronunciation. Discussion materials include short literary and sociological texts, recent films, varied audio and digitized video interviews and the Internet. Taught in French. Enrollment limited to 16.

J. Sadock

21F.311 Introduction to French Culture
Prereq: 21F.304, 21F.374, or permission of instructor
U (Fall)
3-0-9 HASS-D, Category 1

Examines major social and political trends, events, debates and personalities which help place various aspects of contemporary French culture in their historical perspective. Topics include the heritage of the French Revolution, the growth and consequences of colonialism, the role of intellectuals in public debates, the impact of the Occupation, the modernization of the economy and of social structures. Also studied are the sources and meanings of national symbols, monuments, myths and manifestoes. Documents include fiction, films, essays, newspaper articles, and television shows. Recommended for students planning to study abroad. Taught in French.

E. B. Turk

21F.312 Basic Themes in French Literature and Culture
Prereq: 21F.304, 21F.374, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Can be repeated for credit

Introduction to literary and cultural analysis through the close reading and discussion of texts united by a common theme. Taught in French.

E. B. Turk

21F.315 Cross-cultural Perspectives on Contemporary French Society
Prereq: 21F.304, 21F.374, or permission of instructor
U (Fall)
3-0-9 HASS

Intermediate subject designed to help students gradually build an in-depth understanding of France. Focuses on French attitudes and values regarding education, work, family, and institutions. Deals with the differing notions that underlie interpersonal interactions and communications styles, such as politeness, friendship, and formality. Using a web comparative, cross-cultural approach, students explore a variety of French and American materials then analyze and compare using questionnaires, opinion polls, news reports (in different media), as well as a variety of historical, anthropological and literary texts. Students involved in team research projects. Attention given to the development of relevant linguistic skills. Recommended for students planning to study and work in France. Taught in French.

S. Levet

Advanced Subjects in Literature and Culture

Students are required to take at least one intermediate subject before enrolling in advanced subjects. Otherwise they must obtain permission of the instructor.

21F.320 Introduction to French Literature
Prereq: 21F.304, 21F.374, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

A basic study of major French literary genres—poetry, drama, and fiction—and an introduction to methods of literary analysis. Authors include:
Graduate Language Subjects

21F.351 French I
(Subject meets with 21F.301, 21F.371)
Prereq: None
G (Fall, IAP, Spring)
4-0-5
See description under subject 21F.301.
Fall: J. Sadowski, L. Rezvani
Spring: S. Levit

21F.352 French II
(Subject meets with 21F.302, 21F.372)
Prereq: 21F.351
G (Fall, Spring)
4-0-5
See description under subject 21F.302.
C. Culot

GERMAN

The subjects listed below include language, literature, and cultural studies subjects given in German; all are taught in German. The indication of prerequisites for specific German offerings does not apply to students who have already accomplished the equivalent work. For further placement advice, consult one of the field advisors in German. The 9-unit Globalization subjects cover the same material as their 12-unit counterparts, but they may only be taken in conjunction with 21F.076.

For German Literature and Culture subjects offered in English, see 21F.055, 21F.056, and 21F.059.

Fundamental Language Subjects

21F.400 German I (Study Abroad)
(Subject meets with 21F.450)
Prereq: None
U (Fall, Spring)
4-0-8 HASS
Credit cannot also be received for 21F.401
Introduction to German language and culture. Class conducted in Germany with MIT instructors. Acquisition of vocabulary and grammatical concepts through active communication. Audio, video, and printed materials provide direct exposure to authentic German language and culture. Self-paced language lab program is fully coordinated with textbook/workbook. Development of effective basic communication skills. Students responsible for travel and lodging fees.

21F.401 German I
(Subject meets with 21F.451, 21F.471)
Prereq: None
U (Fall, IAP, Spring)
4-0-8 HASS
Credit cannot also be received for 21F.400
Introduction to German language and culture. Acquisition of vocabulary and grammatical concepts through active communication. Audio, video, and printed materials provide direct exposure to authentic German language and culture. Self-paced language lab program is fully coordinated with textbook/workbook. Development of effective basic communication skills. For graduate credit see 21F.451.
Fall: P. Weise
Spring: D. Jaeger

21F.471 German I—Globalization
(Subject meets with 21F.401, 21F.451)
Prereq: None. Coreq: 21F.076
U (Fall)
4-0-5 HASS
In conjunction with 21F.076, covers same material as 21F.401. See description under 21F.401. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.
P. Weise

21F.402 German II
(Subject meets with 21F.452, 21F.472)
Prereq: 21F.401, 21F.471, or permission of instructor
U (Fall, Spring)
4-0-8 HASS
Expansion of basic communication skills and further development of linguistic competency. Review and completion of basic grammar, building of vocabulary, and practice in writing short essays. Reading of short literary texts. Exposure to history and culture of German-speaking countries through audio, video, and web materials. For graduate credit see 21F.452.
D. Jaeger
21F.472 German II—Globalization
(Subject meets with 21F.402, 21F.452)
Prereq: 21F.401 or permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS

In conjunction with 21F.076, covers same material as 21F.402. See description under 21F.402. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.
D. Jaeger

21F.403 German III
(Subject meets with 21F.473)
Prereq: 21F.402, 21F.472, or permission of instructor
U (Fall, Spring)
4-0-8 HASS-D Language Option

Expands skills in speaking, reading, listening, and writing. Develops analytic and interpretative skills through the reading of a full-length drama as well as short prose and poetry (Dürrenmatt, Böll, Borchart, and others) and through media selections on contemporary issues in German-speaking cultures. Discussions and compositions based on these texts. Review of grammar and development of vocabulary-building strategies. Recommended for students with two years of high school German.
Fall: E. Crocker, P. Weise
Spring: P. Weise

21F.473 German III—Globalization
(Subject meets with 21F.403)
Prereq: 21F.402 or permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS

Fulfills corequisite for students taking 21F.076, covers same material as 21F.403. See description under 21F.403. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.
E. Crocker

21F.404 German IV
(Subject meets with 21F.474)
Prereq: 21F.403, 21F.473, or permission of instructor
U (Fall, Spring)
4-0-8 HASS-D Language Option

Development of interpretive skills, using literary texts (B. Brecht, S. Zweig) and contemporary media texts (film, TV broadcasts, Web materials). Discussion and exploration of cultural topics in their current social, political, and historical context via hypermedia documentaries. Further refinement of oral and written expression and expansion of communicative competence in practical everyday situations.
Fall: E. Crocker
Spring: E. Crocker, P. Weise

21F.474 German IV—Globalization
(Subject meets with 21F.404)
Prereq: 21F.403 or permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS

Fulfills corequisite for students taking 21F.076, covers same material as 21F.404. See description under 21F.404. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.
E. Crocker

21F.406 German: Communication Intensive I
Prereq: Permission of instructor
U (Fall, Spring)
3-0-0

21F.407 German: Communication Intensive II
Prereq: Permission of instructor
U (Fall, Spring)
3-0-0

D. Jaeger

Intermediate Subjects in Language, Literature, and Culture

21F.405 Germany Today: Intensive Study of German Language and Culture
Prereq: 21F.403, 21F.473, 21F.404, or 21F.474
U (IAP)
4-0-8 HASS

Prepares students for working and living in German-speaking countries. Focus on current political, social, and cultural issues, using newspapers, TV, radio broadcasts, podcasts, and Web sources from Germany, Austria, and Switzerland. Emphasis on speaking and listening skills for professional contexts. Activities include oral presentations, group discussions, guest lectures, and live interviews with German speakers. No listeners.
E. Crocker

21F.409 Opening the Text: Writing and Performing in German
Prereq: 21F.403 or 21F.473
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9 HASS

Refinement of language skills via the production of students’ texts. Analysis of students’ manuscripts, the close reading of short literary texts from the 20th and 21st centuries, and interpretative performance of texts by students and others. Focus on aesthetic language. How words are embedded in culture and history. Introduction to literary concepts. Discussion of topics in the contemporary German-speaking literary scene. Taught in German.
D. Jaeger

21F.410 Professional Communication in German
Prereq: 21F.404 or 21F.474
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9 HASS

Exposes students to current issues and language use in German technology, business, and international industrial relations; discusses ramifications of these issues in a larger social and cultural context. Prepares students who wish to work or study in a German-speaking country. Focuses on specialized vocabulary and systematic training in speaking and writing skills to improve fluency and style. Emphasizes communicative strategies that are crucial in a working environment. Includes discussion and analysis of newspaper and magazine articles, modern expository prose, and extensive use of online material. Taught in German.
E. Crocker

21F.412 Texts, Topics, and Times in German Literature
Prereq: 21F.404 or 21F.474
U (Fall)
3-0-9 HASS

Familiarizes students with major works of German literature from the 18th century to the present. Readings and extensive discussions of German prose fiction, poetry, and drama. Gives general overview of literary periods and introduction to different forms of literary analysis and interpretation. Discusses relation of author to audience, imitation of reality versus experimentation with reality, intertextuality, and the social and historical context of literary texts. Authors include Lessing, Goethe, E. T. A. Hoffmann,
Kafka, Brecht, Bachmann, Böll, Dürrenmatt, and Sebald. Taught in German.
D. Jaeger

**Advanced Subjects in Language, Literature, and Culture**

**21F.414 German Culture, Media, and Society**
Prereq: 21F.404 or 21F.474
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall) 3-0-9 HASS
Can be repeated for credit
Investigates current trends and topics in German literature, theater, film, television, radio, and other media arts productions. Analyzes media texts in the context of their production, reception, and distribution as well as the public debates initiated by these works. Students have the opportunity to discuss topics with a writer, filmmaker, and/or media artist from Germany. Taught in German. Topics vary from term to term.
K. Fendt

**21F.415 Germany and its European Context**
Prereq: 21F.404 or 21F.474
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring) 3-0-9 HASS
Can be repeated for credit
Examines the historical, political, and sociological forces that shape present-day Germany. Topics vary and may include: value changes in postwar society, coping with the legacy of the past, multiculturalism in Germany, change of gender roles, cultural differences between East and West after the unification, the role of environmentalism, the process of European integration, and Germany and its neighbors. Draws on current articles, texts and videos from newspapers, journals, the Web, and German TV. Integrates and contextualizes the first-hand experiences of German society. Taught in German. Topics vary from term to term.
K. Fendt

**21F.416 Twentieth & Twenty-First Century German Literature**
Prereq: 21F.404 or 21F.474
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9 HASS
Can be repeated for credit with permission of instructor
Introduces students to important 20th- and 21st-century literary texts and connects them to the often dramatic course of German history in the last century. Surveys German literature from the beginning of the 20th century to the most recent post-unification texts. Each term focuses on a different broader theme. Taught in German.
Staff

**21F.420 Visual Histories: German Cinema 1945 to Present**
Prereq: 21F.404, 21F.474, or permission of instructor
Acad Year 2009–2010: U (Fall) 2-2-8 HASS
Acad Year 2010–2011: Not offered
Studies the history, aesthetics, and cultural contexts of German film since the end of World War II. Explores films of “New German Cinema” by Fassbinder, Wenders, Herzog, and others, and investigates the film tradition of East Germany and the internationalization of German cinema since the 1980s. Special thematic focus on the representation of history in film. Films shown with English subtitles. One discussion section per week conducted entirely in German; all writing done in German, readings in both German and English.
K. Fendt

**Graduate Language Subjects**

**21F.450 German I (Study Abroad)**
(Subject meets with 21F.400)
Prereq: None
G (IAP) 4-0-5
Introduction to German language and culture. Class conducted in German with MIT instructors. Acquisition of vocabulary and grammatical concepts through active communication. Audio, video, and printed materials provide direct exposure to authentic German language and culture. Self-paced language lab program is fully coordinated with textbook/workbook. Development of effective basic communication skills. Students responsible for travel and lodging fees. Field trips introduce students to Germany as a site of science and technology, culture and history. Same as 21F.400, but for graduate credit. Credit cannot also be received for 21F.451. Limited enrollment. Lotteried subject.
D. Jaeger

**21F.451 German I**
(Subject meets with 21F.401, 21F.471)
Prereq: None
G (Fall, IAP; Spring) 4-0-5
See description under subject 21F.401.
Fall: P. Weise
Spring: D. Jaeger

**21F.452 German II**
(Subject meets with 21F.402, 21F.472)
Prereq: 21F.451 or permission of instructor
G (Fall, Spring) 4-0-5
See description under subject 21F.402.
D. Jaeger

**Japanese**

The subjects listed below include language, literature, and cultural studies subjects given in Japanese. A variety of literature subjects given in the original language as well as some given in English offer HASS Distribution credit.

All subjects listed below are taught in Japanese. The indication of prerequisites for specific Japanese offerings does not apply to students who have already accomplished the equivalent work. For further placement advice, consult one of the field advisors in Japanese. The 9-unit Globalization subjects cover the same material as their 12-unit counterparts, but they may only be taken in conjunction with 21F.076.

For Japanese Literature and Culture subjects offered in English, see 21F.027J, 21F.039, 21F.063, 21F.064, 21F.065, and 21F.067J.

**Fundamental Language Subjects**

**21F.501 Japanese I**
(Subject meets with 21F.551, 21F.571)
Prereq: None
U (Fall, IAP) 4-0-8 HASS
Introduction to modern standard Japanese. Emphasis on developing proficiency in speaking and listening, using basic grammar and vocabulary. Basic skills in reading and writing are also taught. Lab work required. For graduate credit see 21F.551.
Y. Nagaya
21F.571 Japanese I—Globalization
(Subject meets with 21F.501, 21F.551)
Prereq: None. Coreq: 21F.076
U (Fall, IAP)
4-0-5 HASS

In conjunction with 21F.076, covers same material as 21F.501. See description under 21F.501. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.

Y. Nagaya

21F.502 Japanese II
(Subject meets with 21F.552)
Prereq: 21F.501 or 21F.571; or placement test and permission of instructor
U (Spring)
4-0-8 HASS

Enhancement of the four basic skills. Extension of basic grammar. Vocabulary and kanji (Chinese characters) building. Lab work required. For graduate credit see 21F.552.

Y. Nagaya

21F.503 Japanese III
(Subject meets with 21F.573)
Prereq: 21F.502; or placement test and permission of instructor
U (Fall)
4-0-8 HASS-D Language Option

Development of the four basic skills. Continued vocabulary and kanji building. Lab work required.

I. Shingu

21F.573 Japanese III—Globalization
(Subject meets with 21F.503)
Prereq: 21F.502; or placement test and permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS

In conjunction with 21F.076, covers same material as 21F.503. See description under 21F.503. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.

I. Shingu

21F.504 Japanese IV
Prereq: 21F.503 or 21F.573; or placement test and permission of instructor
U (Spring)
4-0-8 HASS-D Language Option

Review and expansion of basic skills. Emphasis on application of basic grammar and vocabulary in various situations. Lab work required.

Y. Nagaya

21F.505 Japanese V
(Subject meets with 21F.575)
Prereq: 21F.504; or placement test and permission of instructor
U (Fall)
4-0-8 HASS

Systematic development of reading, writing, and oral communication skills. Introduction to advanced grammar that deepens the understanding of Japanese culture and society through reading and discussion. Lab work required.

M. Ikeda-Lamm

21F.575 Japanese V—Globalization
(Subject meets with 21F.505)
Prereq: 21F.504; or placement test and permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS

In conjunction with 21F.076, covers same material as 21F.505. See description under 21F.505. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.

M. Ikeda-Lamm

21F.506 Japanese VI
Prereq: 21F.505 or 21F.575; or placement test and permission of instructor
U (Spring)
3-0-9 HASS

Continuation of 21F.505. Further development of reading, writing, and oral communication skills. Extension of advanced grammar and further enhancement of advanced vocabulary. Variety of cultural elements studied through readings, video, and discussion. Lab work required.

I. Shingu

Advanced Subjects

21F.514 Linguistic Theory and Japanese Language
(Subject meets with 24.946)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-6 HASS

Detailed examination of the grammar of Japanese and its structure which is significantly different from English, with special emphasis on problems of interest in the study of linguistic universals. Data from a broad group of languages studied for comparison with Japanese. Meets with graduate subject 24.946, but assignments differ. Assumes familiarity with linguistic theory.

S. Miyagawa

21F.590 Visualizing Cultures
(Subject meets with 21F.027, 21H.917, CMS.874)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-10 HASS, CI-H

Credit cannot also be received for 21F.027

Examines how visual images shape the identity of peoples and cultures. Uses a prototype digital project looking at American and Japanese graphics depicting the opening of Japan to the outside world in the 1850s to introduce the conceptual and practical issues involved in “visualizing cultures.” Guest lecturers include professionals engaged in various aspects of collecting, analyzing, and presenting graphic images. Taught in English. Students complete some assignments in Japanese. Students not pursuing a minor in Japanese should register for 21F.027.

S. Miyagawa, J. Dower

21F.591 Japanese Popular Culture
(Subject meets with 21F.039)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-10 HASS

Credit cannot also be received for 21F.039

Examines Japanese popular culture as a way of understanding the changing character of media, capitalism, fan communities and cultural differences. Topics include manga (comic books), hip-hop and other popular music in Japan, anime (Japanese animated films) and feature
21F.592 Introduction to Japanese Culture  
(Subject meets with 21F.064)  
Prereq: None  
U (Fall, Spring)  
3-0-10 HASS, D, Category 4, CI-H  
Credit cannot also be received for 21F.064

Examines the major aesthetic, social, and political elements which have shaped modern Japanese culture and society. Readings on contemporary Japan and historical evolution of the culture. Study of literary texts, film, and art, along with the analysis of everyday life and leisure activities. Taught in English. Students complete some assignments in Japanese. Students not pursuing a minor in Japanese should register for 21F.064.

I. Condry

21F.593 Japanese Literature and Cinema  
(Subject meets with 21F.065)  
Prereq: None  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Fall)  
3-0-10 HASS, CI-H  
Credit cannot also be received for 21F.065

Surveys both cinematic and literary representations of diverse eras and aspects of Japanese culture such as the classical era, the samurai age, wartime Japan and the atomic bombings, social change in the postwar period, and the appropriation of foreign cultural themes, with emphasis on the modern period. Directors include Akira Kurosawa and Hiroshi Teshigahara. Authors include Kobo Abe and Yukio Mishima. Films shown with subtitles in English. Taught in English. Students complete some assignments in Japanese. Students not pursuing a minor in Japanese should register for 21F.065.

I. Condry

21F.596 Anime: Transnational Media and Culture (New)  
(Subject meets with 21F.063)  
Prereq: None  
Acad Year 2009–2010: U (Fall)  
Acad Year 2010–2011: Not offered  
3-0-10 HASS

Explores anime (Japanese animated films and TV shows) as a study in flows among media and cultures. Discusses Japan’s substantial share of the TV cartoon market and the reasons for anime’s worldwide success. Focuses on cultural production and the ways anime cultures are created through the interactive efforts of studios, sponsors, fans, broadcasters and distributors. Uses anime scholarship and media examples as a means to examine leading theories in media and cultural studies, gender and sexuality, technology and identity, and post-industrial globalization. Taught in English. Students complete some assignments in Japanese. Students not pursuing a minor in Japanese should register for 21F.063.

I. Condry

ITALIAN

The subjects listed below include language, literature, and cultural studies subjects given in Italian.

All subjects listed below are taught in Italian. The indication of prerequisites for specific Italian offerings does not apply to students who have already accomplished the equivalent work. For further placement advice, consult one of the field advisors in Italian.

Fundamental Language Subjects

21F.601 Italian I  
(Subject meets with 21F.651)  
Prereq: None  
U (IAP)  
4-0-8 HASS

Focus on basic oral expression, listening comprehension, and elementary reading and writing. Emphasis on the acquisition of vocabulary and grammatical concepts through active communication. Designed for students with no knowledge of Italian. Audio, video, and printed materials provide direct exposure to authentic Italian language and culture.

Staff

21F.651 Italian I  
(Subject meets with 21F.601)  
Prereq: None  
G (IAP)  
4-0-5

See description under subject 21F.601.

Staff

SPANISH

The subjects listed below include language, literature, and cultural studies subjects given in Spanish, as well as Special Topics. A variety of literature subjects given in the original language as well as some given in English offer HASS Distribution credit.

All subjects listed below are taught in Spanish. The indication of prerequisites for specific Spanish offerings does not apply to students who have already accomplished the equivalent work. For further placement advice, consult one of the field advisors in Spanish. The 9-unit Globalization subjects cover the same material as their 12-unit counterparts, but they may only be taken in conjunction with 21F.076.

For Spanish Literature and Culture subjects taught in English, see 21F.080 and 21F.084.

Fundamental Language Subjects

21F.701 Spanish I  
(Subject meets with 21F.751, 21F.771)  
Prereq: None  
U (Fall, IAP, Spring)  
4-0-8 HASS

Introduction to understanding, speaking, reading, and writing Spanish. Maximal use of fundamentals of grammar in active communication. Audio- and video-based language laboratory program coordinated with and supplemented to class work. For graduate credit see 21F.751.

Fall: L. Soto  
Spring: R. Gessa

21F.771 Spanish I—Globalization  
(Subject meets with 21F.701, 21F.771)  
Prereq: None. Coreq: 21F.076  
U (Fall)  
4-0-5 HASS

In conjunction with 21F.076, covers same material as 21F.701. See description under 21F.701. Students cannot receive credit without
simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076. 
R. Soto

21F.702 Spanish II
(Subject meets with 21F.752, 21F.772)
Prereq: 21F.701, 21F.771, or permission of instructor
U (Fall, Spring)
4-0-8 HASS
Credit cannot also be received for 21F.782
Introductory subject that continues the study of Spanish language and culture using audio, video and print materials, feature films and popular music from Latin America and Spain. It emphasizes writing, vocabulary acquisition, and the study of more complex grammatical structures. Group interaction and short oral presentations develop students' oral skills. For graduate credit see 21F.752.
Fall: R. Gessa
Spring: L. Soto

21F.772 Spanish II—Globalization
(Subject meets with 21F.702, 21F.752)
Prereq: 21F.701 or permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS
In conjunction with 21F.076, covers same material as 21F.702. See description under 21F.702. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.
R. Gessa

21F.782 Spanish II (Study Abroad)
(Subject meets with 21F.783)
Prereq: 21F.701, 21F.771, or permission of instructor
U (IAP)
4-0-8 HASS
Credit cannot also be received for 21F.702
Increased practice in listening comprehension, reading, and group interaction. Class conducted in Madrid, Spain with an MIT instructor. Students responsible for travel and lodging fees. Trips outside of Madrid allow students to experience Spanish culture and history. Opportunities to visit Spanish companies and research labs. Enrollment limited. Lotteried subject. (Credit cannot also be received for 21F.772.)
R. Gessa

21F.703 Spanish III
(Subject meets with 21F.773)
Prereq: 21F.702, 21F.772, or permission of instructor
U (Fall, Spring)
4-0-8 HASS-D Language Option
Aims at consolidation and expansion of skills in listening comprehension, speaking, reading, and writing. Uses short stories and other readings, films, music, and Web projects (including a multimedia exchange with students in Spain) to study issues of historical and current interest in Hispanic culture.
Fall: D. Morgenstern, L. Soto
Spring: D. Morgenstern

21F.773 Spanish III—Globalization
(Subject meets with 21F.703)
Prereq: 21F.702 or permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS
In conjunction with 21F.076, covers same material as 21F.703. See description under 21F.703. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.
D. Morgenstern, L. Soto

21F.704 Spanish IV
(Subject meets with 21F.774)
Prereq: 21F.703, 21F.773, or permission of instructor
U (Fall, Spring)
4-0-8 HASS-D Language Option
Continued study of the language, literature, and culture of Spanish-speaking countries to improve oral and written communication. Materials include contemporary Spanish and Latin American films, literary texts (short stories, poetry and a novel), online video interviews with a variety of Spanish-speakers and other Web resources.
Fall: M. Ribas Groeger
Spring: R. Gessa, L. Soto

21F.774 Spanish IV—Globalization
(Subject meets with 21F.704)
Prereq: 21F.703 or permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS
In conjunction with 21F.076, covers same material as 21F.704. See description under 21F.704. Students cannot receive credit without simultaneous completion of 21F.076. Restricted to concurrently registered students of 21F.076.
M. Ribas Groeger

21F.705 Oral Communication in Spanish
Prereq: 21F.703, 21F.773, or permission of instructor
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
4-0-8 HASS
Focuses on oral communication supplemented by written work and uses popular media for listening and viewing practice. Projects involve reading, oral presentations, essays, diaries, and classroom interaction. Includes communication skills needed by students in engineering and management for work in Latin America or Spain. Taught in Spanish.
D. Morgenstern

21F.708 Spanish: Communication Intensive I
Prereq: Permission of instructor
U (Fall, Spring)
3-0-0

21F.709 Spanish: Communication Intensive II
Prereq: Permission of instructor
U (Fall, Spring)
3-0-0

Staff

Intermediate Subjects in Language, Literature, and Culture

These subjects (21F.711–21F.714) are designed for students who have completed Spanish IV or its equivalent. They serve as a transition between language study and more advanced subjects in literature and culture. Although each subject has a different emphasis, all provide students with additional practice in reading, speaking, and writing.

It is required that all students take one of the intermediate-level subjects before enrolling in 21F.716 and above. Students may take several subjects from these offerings. Native speakers of Spanish who have studied Hispanic literature at a high school level must seek the instructor's approval for admission to any of these subjects.
21F.711 Advanced Spanish Conversation and Composition: Perspectives on Technology and Culture
Prereq: 21F.704, 21F.774, or permission of instructor
U (Spring)
3-0-9 HASS
Subject designed as a logical complement to Advanced Reading and Writing in Spanish. Unlike 21F.713, which focuses primarily on literary language, subject focuses on expository and journalistic writing that examines the social and cultural impact of science and technology in Hispanic societies. Topics considered are: family structure and community, personal identity, gender relations, relationship to natural world, value systems and religion, education and work-life. Ethical implications of technological decision-making also discussed. Improves oral and written skills through discussions of audiovisual materials, simulations, interviews, guided compositions, regular journal writing, and participation on an online forum. Readings include: journalistic reports, essays, and literary selections offering diverse perspectives. Taught in Spanish.
M. Ribas Groeger

21F.712 Spanish Conversation and Composition
(Subject meets with 21F.792)
Prereq: 21F.704, 21F.774, or permission of instructor
U (Fall)
3-0-9 HASS
Further development of spoken and written skills to improve fluency and style. Oral reports by participants on individual topics and group Web-based and video projects. Analyses of selected literary texts, films and popular music. Taught in Spanish.
D. Morgenstern

21F.713 Advanced Reading and Writing in Spanish
Prereq: 21F.704, 21F.774, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Read and discuss works by authors from diverse quarters of Hispanic culture and consider basic problems of interpretation. Designed to improve a student’s ability to read, discuss, and write about literary texts, and review advanced Spanish grammar. Materials for class discussion and composition include Hispanic novels, novels, short stories, plays, and poems. Taught in Spanish.
R. Gessa

21F.714 Spanish for Bilingual Students
Prereq: Fluency in a Spanish dialect
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Designed for students of Hispanic descent and raised in the US. Expands oral and written skills through the study of grammar and increased contact with standard Spanish. Studies recent fiction and poetry as well as specific historical, social, economic, and political aspects of Mexican-American, Puerto Rican, Cuban and other Hispanic/Latino cultures. Taught in Spanish.
D. Morgenstern

Advanced Subjects in Literature and Culture

It is strongly advised that all students take one of the intermediate-level subjects before enrolling in an advanced subject. Otherwise students are required to obtain permission of the instructor of the advanced subject.

21F.716 Introduction to Contemporary Hispanic Literature and Film
Prereq: One intermediate subject in Spanish or permission of instructor
U (Spring)
3-0-9 HASS-D, Category 1
Studies important 20th- and 21st-century texts and films from both Spain and Latin America. Readings include short stories, theater, the novel, and poetry, as well as some non-fiction. Students acquire skills necessary for a serious examination of literacy and cultural issues in the Spanish-speaking world. Conducted entirely in Spanish. Emphasis on active participation of students in class discussion.
E. Garrels

21F.717 Introduction to Spanish Culture
Prereq: One intermediate subject in Spanish or permission of instructor
U (Fall)
3-0-9 HASS
Studies the major social, political, and aesthetic modes which have shaped Spanish civilization. Coordinates the study of literature, film, art, and architecture with the historical evolution of Spain. Readings and discussions focus on such topics as: the coexistence of Christians, Moors, and Jews; Imperial Spain; the First and Second Republics; and the contemporary period as background for the emergence of distinctively Spanish literary and artistic movements. Taught in Spanish.
C. Ramos

21F.730 Twentieth and Twenty-First Century Hispanic American Literature
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
The Spanish-speaking Americas have just experienced a century of magnificent poetry, world-class fiction, utopian and dystopian politics, hope, nightmare, and the tenacious bravery of everyday life. Concentrates on fiction, poetry, memoirs, testimonials, and urban chronicles from different regions and decades. Possible choices include Dario, Neruda, Vallejo, N. Guillén, Cardenal, Dalton, de la Parra, Bombal, Carpentier, Cortázar, Rufio, Fuentes, Vargas Llosa, Arguedas, García Márquez, Ferré, Bolano, Airé, Eltit, Borges, Quiroga, Paz Soldán, Dorfman, and Lemebel. Conducted in Spanish.
E. Garrels

21F.731 Creation of a Continent: Representations of Hispanic America, 1492–1898, in Literature and Film
Prereq: One intermediate Spanish subject or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Traces the creation of a new literature in Spanish to record and interpret New World experiences. Begins with excerpts from Columbus’s diary and ends with writings on the late 19th-century Cuban and Puerto Rican independence movements. Pairs some of these pre-20th-century texts with more recent literary and film inter-
21F.740 The New Spain: 1977–Present
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9 HASS
Deals with the vast changes in Spanish social, political, and cultural life that have taken place since the death of Franco. New freedom from censorship; the re-emergence of strong movements for regional autonomy: the Basque region and Catalonia; the new cinema including Almodóvar and Saura; educational reforms instituted by the socialist government, and the fiction of Carme Riera and Terenc Moix. Special emphasis placed on the emergence of mass media as a vehicle for expression in Spain. Consideration given to the changes wrought by Spain’s acceptance into the European Community. Material includes magazines, newspapers, films, fiction and Amando de Miguel’s Los Españoles. Taught in Spanish.
M. Resnick

Graduate Language Subjects

21F.751 Spanish I
Subject meets with 21F.701, 21F.771
Prereq: None
Fall: L. Soto
Spring: R. Gessa

21F.752 Spanish II
Subject meets with 21F.702, 21F.772
Prereq: 21F.751 or permission of instructor
G (Fall, Spring)
4-0-5
See description under subject 21F.701.
Fall: L. Soto
Spring: R. Gessa

21F.783 Spanish II (Study Abroad)
Subject meets with 21F.782
Prereq: 21F.751 or permission of instructor
G (IAP)
4-0-5
Increased practice in listening comprehension, reading, and group interaction. Class conducted in Madrid, Spain with an MIT instructor. Students responsible for travel and lodging fees. Trips outside of Madrid allow students to experience Spanish culture and history. Opportunities to visit Spanish companies and research labs. Same as 21F.782, but for graduate credit. Limited enrollment. Lotteried subject. (Credit cannot also be received for 21F.752.)
R. Gessa
### Bachelor of Science in Foreign Languages and Literatures/Course 21F

<table>
<thead>
<tr>
<th>General Institute Requirements (GiRs)</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td></td>
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<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>2</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**

17

<table>
<thead>
<tr>
<th>Communication Requirement</th>
</tr>
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<tbody>
<tr>
<td>The program includes a Communication Requirement of 4 subjects:</td>
</tr>
<tr>
<td>2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and</td>
</tr>
<tr>
<td>2 subjects designated as Communication Intensive in the Major (CI-M).</td>
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</tbody>
</table>

**PLUS Departmental Program**

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

<table>
<thead>
<tr>
<th>Program 1: French Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite subjects: 21F.301, 21F.302</td>
</tr>
</tbody>
</table>

**Required Subjects**

42

| 21F.304 French IV, 12, HASS-D Language Option, 21F.309* |

To satisfy the requirement that students complete two Communication Intensive subjects in the major, students must take 21F.306 and 21F.307. Registration for 21F.306 and 21F.307 must be simultaneous with one of the following: 21F.308, 21F.310, 21F.311, 21F.312, 21F.315, 21F.320, 21F.336, 21F.341, 21F.343, 21F.345, 21F.346, or 21F.347.

**Restricted Electives**

90

A coherent program of 8 subjects beyond French II from the French curriculum, which may include a pre-thesis tutorial and a thesis.

<table>
<thead>
<tr>
<th>Program 2: Spanish Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite subjects: 21F.701, 21F.702</td>
</tr>
</tbody>
</table>

**Required Subjects**

42

| 21F.704 Spanish IV, 12, HASS-D Language Option, 21F.703* |

To satisfy the requirement that students complete two Communication Intensive subjects in the major, students must take 21F.708 and 21F.709. Registration for 21F.708 and 21F.709 must be simultaneous with one of the following range of subjects: 21F.716, 21F.717, 21F.730, 21F.731, 21F.735, 21F.736, 21F.738, 21F.740, or 21F.742.

**Restricted Electives**

90

A coherent program of 8 subjects beyond Spanish II from the Spanish curriculum, which may include a pre-thesis tutorial and a thesis.

<table>
<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GiRs</th>
</tr>
</thead>
</table>

(36)

### Notes

* Alternate prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
Interdisciplinary investigation of three of the best-documented pre-modern empires: the Roman empire of Augustus, the Frankish empire of Charlemagne, and the English empire in the age of the Hundred Years' War. Focuses on how large, multiethnic empires were created, sustained, legitimated, and contested through wars, violence, or even terror. Goal is to explain why some revolutions succeed and others fail. Materials include the writings of revolutionaries, declarations and constitutions, music, films, art, novels, memoirs, and newspapers.

*J. Ravel, C. Wilder, E. Wood*

Course 21H History

**21H.001 How to Stage a Revolution**
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 5, CI-H
Explores fundamental questions about the causes and nature of revolutions by looking at how people overthrow their rulers and establish new governments. Considers a set of major political transformations throughout the world and across centuries to understand the meaning of revolution and evaluate its impact. Examines how revolutionaries have attempted to establish their ideals and realize their goals. Asks whether radical upheavals require bloodshed, violence, or even terror. Goal is to explain why some revolutions succeed and others fall. Materials include the writings of revolutionaries, declarations and constitutions, music, films, art, novels, memoirs, and newspapers.

*A. Bahr, W. Broadhead, E. Goldberg*

**21H.007 Empire: Introduction to Ancient and Medieval Studies (New)**
(Same subject as 21L.014J)
Prereq: None
U (Fall)
3-0-9 HASS

Interdisciplinary investigation of three of the best-documented pre-modern empires: the Roman empire of Augustus, the Frankish empire of Charlemagne, and the English empire in the age of the Hundred Years' War. Focuses on how large, multiethnic empires were created, sustained, legitimated, and contested through conquest, government, literature, art, architecture, thought, social relationships, economic organization, and technology. Students examine several different types of evidence, read across a variety of disciplines, and develop skills to identify continuities and changes in ancient and medieval societies.

*J. Ravel, C. Wilder, E. Wood*

**21H.101 American History to 1865**
Prereq: None
U (Fall)
3-0-9 HASS

A basic history of American social, economic, and political development from the colonial period through the Civil War. Examines the colonial heritages of Spanish and British America; the American Revolution and its impact; the establishment and growth of the new nation; and the Civil War, its background, character, and impact. Readings include writings of the period by Winthrop, Paine, Jefferson, Madison, W. H. Garrison, G. Fitzhugh, H. B. Stowe, and Lincoln.

*P. Maier*

**21H.102 American History since 1865**
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 5, CI-H

Examines the history of American politics, economics, and society from the Civil War to the present. Use of secondary accounts and primary documents such as court cases, letters and diaries, photographs, and films to examine some of the key issues in the development of modern America: industrialization and urbanization, US emergence as a global power, growth of consumer culture, and the development of the civil rights movement.

*C. Capozzola*

**21H.104J Riots, Strikes, and Conspiracies in American History**
(Same subject as 11.015J)
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 5, CI-H

Readings and discussions focusing on a series of short-term events that shed light on American politics, culture, and social organization. Events studied include the Boston Tea Party of 1773; the crisis at Boston over the case of Anthony Burns, an escaped slave, in 1854; the Homestead strike of 1892; and the student uprisings at Columbia University in 1968. Emphasis on finding ways to make sense of these complicated, highly traumatic events, and on using them to understand larger processes of change in American history.

*P. Maier, R. M. Fogelson*

**21H.105 American Classics**
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 5, CI-H

Students read, discuss, and write about critical works in American history from the 17th through the 20th centuries. Includes writings by early Puritan writers, Franklin, Paine, Jefferson, and Madison; Lewis and Clark; Frederick Douglass; Harriet Beecher Stowe; the Lincoln-Douglas debates; U. S. Grant, W. E. B. Du Bois, Andrew Carnegie, Horatio Alger, F. D. Roosevelt, Betty Friedan, and Martin Luther King, Jr. May also include music, recorded speeches, television programs, visual images, or films.

*P. Maier*

**21H.106J Black Matters: Introduction to Black Studies**
(Same subject as 24.912J, SP.417J, 21A.114J, 21L.008J, 21M.630J, 21W.741J)
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 4, CI-H

See description under subject 21M.630J.

*T. DeFrantz, S. Alexandre, C. Capozzola*

**21H.112 The American Revolution**
Prereq: None
U (Spring)
3-0-9 HASS

English and American backgrounds of the Revolution; issues and arguments in the Anglo-American conflict; colonial resistance and the beginnings of republicanism; the Revolutionary War; constitution writing for the states and nation; and effects of the American Revolution. Concerned primarily with the revolutionary origins of American government and laws. Readings emphasize documents from the period—pamphlets, correspondence, the minutes or resolutions of resistance organizations, constitutional documents and debates.

*P. Maier*
21H.115 Christianity in America
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
C. Wilder

21H.116 The Civil War and Reconstruction
(Same subject as STS.029J)
(Subject meets with STS.423)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Anti-slavery and the intensification of sectionalism in the 1850s; the secession crisis; political and military developments in the Civil War years; why the North won; and the political, economic, and social legacies of the conflict.
M. R. Smith

21H.117 The Black Radical Tradition in America (New)
Prereq: None
U (Spring)
3-0-9 HASS
Focuses on American history from the African-American perspective. Includes alternative visions of the nation's future, and definitions of its progress, that have called for a fundamental restructuring of political, economic and social relations. Introduces events, figures and institutions that have shaped African-American history, from the struggles to dominate the African coast and the emergence of a modern slave trade, through the fall of the Western slave societies. Also examines the experiences of Africans in other parts of North America, as well as South America and the Caribbean.
C. Wilder

21H.126 America in Depression and War
Prereq: None
U (Spring)
3-0-9 HASS
The Great Depression and World War II permanently changed American politics and society. Topics include: the Great Crash, the New Deal, Roosevelt, the home front, the Normandy Invasion, and the atomic bomb. Explores those events through film, posters, newspapers, and other historical documents.
M. Jacobs

21H.131 The United States in the Nuclear Age: Politics, Culture, and Society Since 1941
Prereq: None
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9 HASS
American experience at home and abroad from Pearl Harbor to the end of the Cold War. Topics include: America's role as global superpower, foreign and domestic anticommunism, social movements of left and right, suburbanization, and popular culture.
M. Jacobs

21H.150J Introduction to Asian American Studies: Literature, Culture, and Historical Experience
(Same subject as 21F.043J)
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 HASS
See description under subject 21F.043J.
E. Teng

21H.153J Race and Gender in Asian America
(Same subject as SP.603J, 21F.069J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
See description under subject 21F.069J.
E. Teng

21H.206 American Consumer Culture
Prereq: None
U (Fall)
2-0-10 HASS
Examines how and why 20th-century Americans came to define the "good life" through consumption, leisure, and material abundance. Explores how such things as department stores, advertising, mass-produced cars, and suburbs transformed the American economy, society, and politics.
M. Jacobs

21H.221J Migration and Immigration in US History
(Same subject as 11.019J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Examines the history of the United States as a "nation of immigrants" within a broader global context. Considers migration from the mid-19th century to the present through case studies of such places as New York's Lower East Side, South Texas, Florida, and San Francisco's Chinatown. Examines the role of memory, media, and popular culture in shaping ideas about migration. Includes optional field trip to New York City.
C. Capozzola

21H.223 War and American Society
Prereq: None
U (Fall)
3-0-9 HASS
Throughout American history, the experience of war has shaped the ways that Americans think about themselves, their fellow citizens, and the meanings of American citizenship. Examines how Americans have told the stories of modern war in multiple forms such as history, literature, film, and popular culture from the First World War to the war in Iraq, and interprets media representations in terms of changing ideas about American identity.
C. Capozzola

21H.224 Constitutional Law in US History
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Introduces major themes and patterns of change in American constitutional law since 1787, including federal-state relations, racial and gender equality, economic regulation, and civil liberties. Readings consist of original court cases, especially from the US Supreme Court, including cases of the current term. Emphasis on the historical development of constitutional law and on the relationship between the Supreme Court and broader social, political, and cultural trends.
C. Capozzola
21H.225J Gender and the Law in US History
(Same subject as SP.607J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

Explores the legal history of the US as a gendered system. Examines how women have shaped the meanings of American citizenship through pursuit of political rights such as suffrage, jury duty, and military service, as well as how the legal system has shaped gender relations for both women and men through regulation of such issues as marriage, divorce, work, reproduction, and the family. Readings draw from primary and secondary materials, focusing on the broad historical relationship between law and society. No legal knowledge is required or assumed.
C. Capozzola

21H.231J American Urban History I
(Same subject as 11.013J)
Prereq: None
U (Spring)
2-0-7 HASS
See description under subject 11.013J.
R. M. Fogelson

21H.232J American Urban History II
(Same subject as 11.014J)
Prereq: None
U (Fall)
2-0-7 HASS
See description under subject 11.014J.
R. M. Fogelson

21H.234J Downtown
(Same subject as 11.026J)
(Subject meets with 11.339)
Prereq: None
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
2-0-7 HASS

Seminar on downtown in US cities from the late 19th century to the late 20th. Emphasis on downtown as an idea, place, and cluster of interests, on the changing character of downtown, and on recent efforts to rebuild it. Considerers subways, skyscrapers, highways, urban renewal, and retail centers. Focus on readings, discussions, and individual research projects. Meets with graduate subject 11.339, but assignments differ.
R. M. Fogelson

21H.235 Metropolis: A Comparative History of New York City (New)
Prereq: None
U (Fall)
3-0-9 HASS

Examines the evolution of New York City from 1607 to the present. Readings focus on the city’s social and physical histories. Discussions compare New York’s development to patterns in other cities.
C. Wilder

EUROPEAN HISTORY

21H.301 The Ancient World: Greece
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 5, CI-H

History of Ancient Greece from the Bronze Age to the death of Alexander. Major social, economic, political, and religious trends. Homer, heroism, and the Greek identity; the hoplite revolution and the rise of the city-state; Herodotus, Persia, and the (re)birth of history; Empire, Thucydidean rationalism, and the Peloponnesian War; Aristotle, Macedonia, and Hellenism. Emphasis on use of primary sources in translation.
S. Ostrow

21H.302 The Ancient World: Rome
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 5, CI-H

History of Rome from its humble beginnings to the 5th century AD First half: Kingship to Republican form; the conquest of Italy; Roman expansion: Pyrrhus, Punic Wars and provinces; classes, courts, and the Roman revolution; Augustus and the formation of empire. Second half: Virgil to the Vandals; major social, economic, political and religious trends at Rome and in the provinces. Emphasis on use of primary sources in translation.
W. Broadhead

21H.306 The Medieval World: 200–1500
Prereq: None
U (Spring)
3-0-9 HASS

Survey of the history of western Europe, Byzantium, and the Islamic World between 200 and 1500. Topics include the late Roman Empire and the “barbarian” invasions; the emergence of Christianity and the Church; the formation of the Carolingian, Byzantine, and Islamic empires; the Vikings and Mongols; castles, knights, and “feudalism”; medieval warfare and the crusades; religious thinkers, reformers, and heretics; the experience of women and Jews; the rise of cities and trade; the Black Death and the fall of Constantinople.
E. Goldberg

21H.308 The Vikings
Prereq: None
U (Fall)
3-0-9 HASS

Explores the complex relationship of the Vikings with the medieval world, examines developments within Scandinavian society such as state formation, social structures, trade, shipbuilding, slavery, urban growth, and Christianization. Considers the methodological difficulties presented by the diverse and often contradictory historical sources for information about the Vikings, such as monastic chronicles, archaeology, coin hoards, stone inscriptions, and sagas.
E. Goldberg

21H.309 Charlemagne: Emperor of Europe (New)
Prereq: None
U (Spring)
3-0-9 HASS

Investigates the life, reign, and world of the medieval emperor Charles the Great or Charlemagne (768–814). Focuses on the central question of how Charlemagne forged the first medieval empire out of the diverse peoples and territories of Europe, not only through warfare and military might, but through Christianity and the Church, educational and cultural reforms, government and law, art and architecture, and a fundamental reorganization of the economy and society. Considers the enduring contributions of Charlemagne to the formation of Europe as well as the shortcomings and failures of his empire.
E. Goldberg

21H.311 The Renaissance: 1300–1600
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

European history from the 14th through the 16th century. Consideration of political, social, artistic, and scientific developments during this period of transition to the modern world. Examines the connections between Renaissance Humanism and the Protestant and Catholic reform movements of the 16th century. Studies works by Petrarch, Machiavelli, Brunelleschi, Leonardo, Erasmus, More, Luther, and Montaigne.
J. Ravel
An exploration of the changing role of the monarchy in British politics and culture, beginning with the accession of the House of Hanover (later Windsors) in 1714. The dynasty has encountered a series of crises, in which the personal and the political have been inextricably combined: for example, George III’s mental illness; the scandalous behavior of his son, George IV; Victoria’s withdrawal from public life after the death of Prince Albert; the abdication of Edward VIII; and the public antagonism sparked by sympathy for Diana, Princess of Wales. In addition to readings, materials include portraits, news footage, and films.

H. Ritvo

French politics, culture, and society from Louis XIV to Napoleon Bonaparte. Attention given to the growth of the central state, the beginnings of a modern consumer society, the Enlightenment, the origins and course of the French Revolution, and the rise and fall of Napoleon.

J. Ravel

Through close examination of the emperor Augustus and his Julio-Claudian successors, this subject investigates how Roman emperors used art, architecture, coinage, and other media to create and project an image of themselves, how the surviving literary sources from the Roman period reinforced or subverted that image, and how both phenomena have contributed to post-classical perceptions of Roman emperors. Also considers works of Suetonius and Tacitus, and modern representations of the emperors such as those found in the films I, Claudius, Quo Vadis, and HBO’s Rome series.

W. Broadhead

Historical topography of the Greek and Roman city. Investigates the relationship between urban architecture and the political, social, and economic role of cities in the Greek and Roman world. Analyzes a range of archaeological and literary evidence relevant to the use of space in Greek and Roman cities (Athens, Paestum, Rome, and Pompeii). Subjects of detailed study include the sanctuary of Athena on the Athenian Acropolis, the atrium houses of Roman Pompeii, the Athenian Agora and the Roman Forum, feeding the ancient city, and the great bath complexes of Imperial Rome.

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W. Broadhead
21H.466 Imperial and Revolutionary Russia: Culture and Politics
Prereq: None
U (Fall)
3-0-9 HASS
Analyzes Russia's social, cultural, and political heritage. Compares reforming and revolutionary impulses in the context of serfdom, the rise of the intelligentsia, and debates over capitalism. Focuses on historical and literary texts, especially the intersections between the two.
E. Wood

(Same subject as 17.57I)
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 4
Explores political and historical evolution of Soviet state and society from 1917 Revolution to its demise in 1991. Subject covers the creation of a revolutionary regime; causes and nature of the Stalin revolution; post-Stalinist efforts to achieve radical political and social reform; and causes of the Soviet collapse. Also examines current developments in Russia in light of Soviet history.
E. Wood

ASIAN HISTORY

21H.504 East Asia in the World: 1500–2000 AD
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 5, CI-H
Examines the interactions of East Asia with the rest of the world and the relationships of each of the East Asian countries with each other, from ca. 1500 to 2000 AD. Primary focus on China and Japan, with some reference to Korea, Vietnam, and Central Asia. Asks how international diplomatic, commercial, military, religious, and cultural relationships joined with internal processes to direct the development of East Asian societies. Addresses perceptions and misperceptions among East Asians and foreigners.
I. Chapman

21H.511 Chinese Popular Religion
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Explores China's popular religious practices in their social and sectarian contexts, from the ancient to the contemporary. Examines questions raised and solutions offered by Chinese religious traditions. Examples include changing notions of the soul and afterlife; the roles of family, village, temple and state in religious life; how gender affects salvation; and the relationship between religion, science, and political ideologies. Addresses the religious revival in post-Mao China, and tradition and innovation in Taiwan and Hong Kong.
I. Chapman

21H.523 History of Modern Japan, 1853–2000
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 5
Covers Japan's emergence as a modern state and global power. Examines the end of the policy of national seclusion and crumbling of Tokugawa rule, the formation of the modern Meiji state (1868–1912), Japanese imperialism, social and political movements, the costs of rapid modernization, the road to war and defeat in World War II, the U.S. occupation, the postwar economic miracle, "internationalization", and the social and cultural transformations of the 1980s and 1990s.
I. Chapman

21H.546 World War II in Asia: Film, Fantasy, Fact
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Propaganda and ideology in World War II, as seen especially through Japanese and American eyes, from the invasion of China in 1937 through the use of the atomic bomb and Japan's surrender in 1945. This graphic cross-cultural approach raises questions of national and racial stereotyping, and challenges students to assess how the role of prejudice, emotion, and irrationality influenced wartime policies and shaped perceptions of the enemy. Uses extensive written materials from the Japanese side and a large number of visual materials including classic wartime films from both sides.
Staff

21H.560 Smashing the Iron Rice Bowl: Chinese East Asia
(Subject meets with 21F.191)
Prereq: None
U (Fall)
2-0-7 HASS
Credit cannot also be received for 21F.191
Examines the experiences of ordinary Chinese people as they lived through tumultuous change in the 20th century. Class discussion focuses on personal memoirs and films. Includes comparisons between the People's Republic of China, Taiwan, and Hong Kong.
I. Chapman

21H.571 History of Modern South Asia
Prereq: None
U (Fall)
3-0-9 HASS, CI-H
Survey of Indian civilization from 2500 BC to present day. Traces major political events as well as economic, social, ecological, and cultural developments. Primary and secondary readings enhance understanding of this unique civilization, and shape and improve understanding in analyzing and interpreting historical data. Examines major thematic debates in Indian history through class discussion.
H. Roy

21H.573 Religion and Politics in Modern South Asia
Prereq: None
U (Spring)
3-0-9 HASS
Examines how religion and politics have shaped identities, societies and the historical past in modern South Asia. Explores the growth and dissemination of major South Asian religions including Hinduism, Islam, Buddhism, Jainism and Sikhism in ancient and early modern India. Focuses on formation of religious identities within the politics of nationalism and colonialism. Examines how religion has influenced recent geopolitics of South Asia, with specific focus on India, Pakistan, and Bangladesh.
H. Roy

21H.575J Women in South Asia from 1800 to Present
(Same subject as SP.459J)
Prereq: None
U (Fall)
2-0-10 HASS
Exploration of the changes and continuities in the lives of South Asian women. Using gender as a lens, examines how politics of race, class, caste, and religion have affected women in South Asian countries, primarily in India, Pakistan, Bangladesh and Sri Lanka. Current debates within South Asian women's history illustrate the issues and problems that arise in re-writing the past from a gendered perspective. Primary documents, secondary readings, films, newspaper articles, and the Internet.
H. Roy
Examines how the history of modern India has been recorded and reconstructed in diverse media. Primary documents, films, novels, short stories and secondary documents written by historians serve as tools of analysis to explore the connections between history and popular culture. Themes include Indian nationalism, British imperialism, Partition and Independence, communalism, urban-rural linkages, and the construction of class, caste, and gendered identities.

H. Roy

21H.579 Gandhi’s India
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

Mohandas K. Gandhi’s iconic status, both in India and abroad, owes much to his leadership role in the struggle for Indian independence from British rule. Gandhi’s philosophy of non-violence, political morality, and his critique of western modernity were developed in the context of the history of the Indian nationalist movement and are inextricably linked to it. Examines the emergence of Gandhi and his legacy within the context of the anti-colonial nationalist movement in India. Introduction to the tools of the historian’s craft such as interpretation based on critical reading of primary texts and secondary historical analyses.

H. Roy

21H.580 From the Silk Road to the Great Game: China, Russia, and Central Asia, 500–2000 AD
Prereq: None
U (Spring)
3-0-9 HASS

Examines interactions across the Eurasian continent between Russians, Chinese, Mongolian nomads, and Turkic oasis dwellers during the last millennium and a half. As empires rose and fell, religions, trade, and war flowed back and forth continuously across this vast space. Britain and Russia competed for power over Eurasia in the “Great Game” of geopolitics in the 19th century, just as China, Russia, and others did in the 20th century. Today, the fall of the Soviet Union and China’s reforms have opened new opportunities for cultural interaction. Topics include the religious traditions of Central Asian Islam, Buddhism, Christianity, and Confucianism; caravans and travelers like Marco Polo and Rabban Sauma, the first Chinese to travel to the West; and nomadic conquest and imperialist competition, past and present. Source materials include primary documents, travelogues, films, and music from Yo Yo Ma’s Silk Road Project.

I. Chapman

MIDDLE EASTERN HISTORY

21H.601 Islam, the Middle East, and the West
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 5

Provides students with an overview of basic themes and issues in Middle Eastern history from the rise of Islam to the present, with an emphasis on exchanges and encounters between the Middle East and Europe/ North America. Examines the history of the notion of “East” and “West”; the emergence of Islam and the Christianization of Europe; Ottoman expansion and the flourishing of European powers; European competition with and colonization of Middle Eastern societies, and Middle Eastern responses.

B. Der Matossian

21H.615 The Middle East in the Twentieth Century
Prereq: None
U (Spring)
3-0-9 HASS, CI-H

Surveys major political, socio-economic, and cultural changes in the Middle East after 1900. Investigates the demise of the Ottoman and Qajar dynasties, the rise of new nations and nationalist identities, and the development of modern states and societies. Examines contemporary issues in historical perspective: the Arab-Israeli conflict, the Gulf War, oil and regional security, the impact of the Iranian revolution, and Islamic movements. Heavy emphasis on primary sources, such as novels and historical documents. Enrollment limited.

B. Der Matossian

21H.621 Nation, Faith, and Gender in the Modern Middle East
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

Surveys the development of national, religious, and gendered identities in the Middle East during the 19th and 20th centuries. Examines European imperialism, theories of nationalism, and state formation in the successor states of the Ottoman Empire, as well as Iran. Considers national identities in light of minority, gender, and sectarian issues. Topics include Arab nationalism, Zionism, Palestinian nationalism, and regional case studies.

Staff

LATIN AMERICAN HISTORY

21H.802 Latin America: Revolution, Dictatorship, and Democracy, 1850 to Present
Prereq: None
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9 HASS

Selective survey of Latin American history from the mid-19th century to the present. Issues studied include: dictators and democracies in the 20th century, revolution in Mexico, Cuba, and Central America, Latin America in the global economy, relations between Latin America and the U.S., indigenism, feminism, and the varieties of religion in Latin America.

J. Ravel

COMPARATIVE HISTORY SUBJECTS

21H.909 People and Other Animals
(Subject meets with 21H.969)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
2-0-10 HASS

A historical exploration of the ways that people have interacted with their closest animal relatives, for example: hunting, domestication of livestock, worship of animal gods, exploitation of animal labor, scientific study of animals, display of exotic and performing animals, and...
petkeeping. Themes include changing ideas about animal agency and intelligence, our moral obligations to animals, and the limits imposed on the use of animals.

H. Ritvo

21H.912 The World Since 1492
Prereq: None
U (Fall) 3-0-9 HASS-D, Category 5

Focus on four related themes: struggles between Europeans and colonized peoples; industrialization and the global emergence of capitalist economies; the formation of modern states and the challenges to them; and the development of modern consumer society. Topics include: the French and Haitian Revolutions; the partition of Africa; the two World Wars; and the emergence of advertising. Readings include both historical analysis and documents from the periods under investigation.

B. Der Matossian

21H.914 Jewish History from Biblical to Modern Times
Prereq: None
U (Fall) 2-0-10 HASS

Examines how our views of Jewish history have been formed and how this history can explain the survival of the Jews as an ethnic/religious group into the present day. Special attention to the partial and fragmentary nature of our information about the past, and the difficulties inherent in decoding statements about the past that were written with a religious agenda in mind. Considers complex events in Jewish history—early history as portrayed in the Bible to recent history, including the Holocaust.

P. Temin

21H.916 The Ghetto: From Venice to Harlem
Prereq: None
U (Spring) 2-0-10 HASS

Provides an in-depth look at a modern institution of oppression: the ghetto. Uses literature to examine ghettoization over time and across a wide geographical area, from Jews in Medieval Europe to African-Americans and Latinos in the 20th-century United States. Also explores segregation and poverty in the urban “Third World.”

C. Wilder

21H.917J Visualizing Cultures
(Same subject as 21F.027J)
(Subject meets with 21F.590, CMS.874)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring) 3-0-9 HASS, CI-H

See description under subject 21F.027J.
S. Miyagawa, J. Dower

21H.927J Gender and Work: From the Middle Ages to the Contemporary World
(Same subject as SP.610J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring) 2-0-10 HASS

Explores men’s and women’s labor time as it is allocated between market and home-production, as well as their differentiated access to the consumption of goods and leisure. Another major theme involves the reproductive strategies of women, both in conjunction with, and in opposition to, their families. Examines how an ideal of the domestic sphere arose in early modern western Europe, and addresses the extent to which it limited the economic position of women. Analyzes how this ideal has been challenged, and with what success in the post-industrial period. Focuses on western Europe since the Middle Ages and on the United States, but also examines how these issues have played themselves out in non-Western cultures. Students are expected to complete a substantial seminar paper on a relevant topic of their own choosing, as well as contribute to the discussion of a common set of readings.

Staff

SPECIAL SUBJECTS IN HISTORY

21H.931 Seminar in Historical Methods
Prereq: Two History subjects
U (Spring) 2-0-10 HASS

Examines the distinctive ways in which historians in different parts of the world have approached the task of writing history. Explores methodologies used, such as political, social, economic, cultural, and popular histories through the reading and discussion of relevant and innovative texts. Introduction to a variety of sources (archival documents, statistical data, film, fiction, memoirs, artifacts, and images) and the ways they can be used to research, interpret, and present the past. Assignments include weekly two-page response papers and an original research paper (including a proposal, bibliography, first draft, and final version, based on primary sources) in conjunction with a formal oral presentation. Open to all students interested in history.

C. Capozzola

21H.932 Special Topics in History
Prereq: None
U (Fall, IAP) Units arranged
Can be repeated for credit

21H.933 Special Topics in History
Prereq: None
U (Spring) Units arranged
Can be repeated for credit

Individual supervised work for students who wish to study topics not covered in the regular history offerings. Before registering for this subject, a student must plan a course of study with a member of the History Faculty and secure approval from the Head of the History Faculty. HASS credit for Special Topics subjects awarded only by individual petitions to the Committee on Curricula. Normal maximum is 6 units; to count toward HASS Requirement, 9 units are required. Exceptional 9-unit projects occasionally approved.

Staff

21H.ThT History Pre-Thesis Tutorial
Prereq: None
U (Fall, Spring) 2-0-10
Can be repeated for credit

Students writing a thesis in History develop their research topics, review relevant research and scholarship, frame their research questions and arguments, choose an appropriate methodology for analysis, and draft the introductory and methodology sections of their theses. Includes substantial practice in writing (with revision) and oral presentations.

Staff

21H.ThU History Thesis
Prereq: 21H.ThT
U (Fall, Spring) Units arranged
Can be repeated for credit

Completion of work on the senior major thesis under supervision of a faculty thesis advisor. Includes oral presentation of thesis progress early in the term, assembling and revising the final text, and a final meeting with a committee of faculty evaluators to discuss the successes and
History

limitations of the project. Required for students pursuing a full major in History.

Staff

GRADUATE SUBJECTS IN HISTORY

21H.952] Reading Seminar in American History, 1877 to the Present
(Same subject as STS.410J)
Prereq: STS.210J/21H.991J
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Aims to develop a teaching knowledge of the field through extensive reading and discussion of major works. The reading covers a broad range of topics—political, economic, social, and cultural—and represents a variety of historical methods. Students make frequent oral presentations and prepare a 20-page review essay.

M. Jacobs

21H.968] Nature, Environment, and Empire
(Same subject as STS.415J)
Prereq: 21H.991J/STS.210J
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

An exploration of the relationship between the study of natural history, both domestic and exotic, by Europeans and Americans, and concrete exploitation of the natural world, focusing on the 18th and 19th centuries.

H. Ritvo

21H.969 People and Other Animals
(Subject meets with 21H.909)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
2-0-10

A historical survey of the ways that people have interacted with their closest animal relatives, for example: hunting, domestication of livestock, worship of animal gods, exploitation of animal labor, scientific study of animals, display of exotic and performing animals, and petkeeping. Themes include changing ideas about animal agency and intelligence, our moral obligations to animals, and the limits imposed on the use of animals.

H. Ritvo

21H.991] Theories and Methods in the Study of History
(Same subject as STS.210J)
Prereq: Permission of instructor
G (Fall)
3-0-9

Focuses on the development of social and cultural history in the 20th century. Topics include the rise of the Annales school, agrarian history, class, race, and gender as historical categories, historical demography, new economic, and environmental history, microhistory, and history on film. Topics drawn from European, American, and Asian history. Open to qualified undergraduates.

J. Ravel

21H.992 Advanced Topics in History
Prereq: None
G (Fall)
Units arranged

21H.993 Advanced Topics in History
Prereq: None
G (Fall)
Units arranged

Individual supervised work for graduate students on a topic or field of history not covered at the graduate level in the regular history offerings. Before registering for this subject, a student must plan a course of study with a member of the History Faculty and secure the approval of the head of the History Faculty.

Staff

21H.996 Advanced Topics in History
Prereq: None
G (Spring)
Units arranged

Individual supervised work for graduate students on a topic or field of history not covered at the graduate level in the regular history offerings. Before registering for this subject, a student must plan a course of study with a member of the History Faculty and secure the approval of the head of the History Faculty.

Staff

For individual research in History, register for 21H.UR or 21H.URG. Descriptions of these subjects can be found in the beginning of this section under 21.UR and 21.URG. For History pre-thesis tutorial, register for 21H.ThT. For undergraduate thesis, register for 21H.ThU.
### Bachelor of Science in History/Course 21H

#### General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [three subjects can be satisfied by subjects in the Departmental Program]</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td>17</td>
</tr>
</tbody>
</table>

#### Communication Requirement

The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M).

#### PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Subjects</td>
<td>57–60</td>
</tr>
<tr>
<td>One 21H HASS-D subject (12 units)</td>
<td></td>
</tr>
<tr>
<td>One 21H seminar subject (9-12 units)</td>
<td></td>
</tr>
<tr>
<td><strong>21H.931</strong> Seminar in Historical Methods, 12, CI-M, HASS *</td>
<td></td>
</tr>
<tr>
<td><strong>21H.932</strong> History Pre-Thesis Tutorial, 12</td>
<td></td>
</tr>
<tr>
<td><strong>21H.933</strong> History Thesis, 12, CI-M *</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives</td>
<td>72–102</td>
</tr>
<tr>
<td>A coherent program of six subjects from the history curriculum; and three related subjects from a second HASS discipline.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th>(27–33)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>48–72</td>
</tr>
</tbody>
</table>

| Total Units Beyond the GIRs Required for SB Degree     | 180     |

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

#### Notes

*Prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
1) Introductory subjects (21L.001–21L.017), all carrying HASS Distribution and Communications Intensive (CI-H or CI-HW) credit.

2) Samplings (21L.310–21L.335) are six-unit subjects that provide both an alternative route into literary study and a less intensive means for students to sustain a commitment to reading and textual interpretation. These subjects focus on critical exploration, textual comprehension, and group discussion, with less sustained attention to analytic writing skills. Students can combine two six-unit Samplings subjects to count as a single 12-unit HASS Elective, equivalent to a subject in the Intermediate tier. No more than four Sampling subjects may be combined in this manner.

3) Intermediate subjects (21L.420–21L.512), some carrying HASS Distribution credit and some limited to students who have already taken one literature course. Intermediate subjects explore literary forms in greater depth and center on historical periods, literary themes, or genres. Students are encouraged to consult individual instructors about prerequisite requirements.

4) Seminars (21L.701–21L.715), restricted to students who have taken at least two previous subjects in literature. Enrollment in seminars is strictly limited to a maximum of 12 students.

A supplement to this catalogue, available online and from the Literature Section offices, offers more detailed descriptions of all literature subjects and includes specific information about required texts, writing assignments, and examinations.

**Introductory Subjects**

21L.000| Writing About Literature
---|---
Prereq: None
U (Fall, Spring)
3-0-9 HASS, CI-HW

Intensive focus on the reading and writing skills used to analyze literary texts such as poems by Emily Dickinson, Shakespeare or Langston Hughes; short stories by Chekhov, Joyce, or Alice Walker; and a short novel by Melville or Toni Morrison. Designed not only to prepare students for further work in writing and literary and media study, but also to provide increased confidence and pleasure in their reading, writing, and analytical skills. Students write or revise essays weekly. Enrollment limited. Fall: W. Kelley Spring: I. Lipkowitz

21L.001| Foundations of Western Culture: Homer to Dante
---|---
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 2, CI-H

Studies a broad range of texts essential to understanding the two great sources of Western conceptions of the world and humanity's place within it: the ancient world of Greece and Rome and the Judeo-Christian world that challenged and absorbed it. Readings vary but usually include works by Homer, Sophocles, Aristotle, Plato, Virgil, St. Augustine, and Dante. Enrollment limited. Fall: W. Kelley Spring: I. Lipkowitz

21L.002| Foundations of Western Culture: The Making of the Modern World
---|---
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 2, CI-H

Complementary to 21L.001. A broad survey of texts, literary, philosophical, and sociological, studied to trace the growth of secular humanism, the loss of a supernatural perspective upon human events, and changing conceptions of individual, social, and communal purpose. Stresses appreciation and analysis of texts that came to represent the common cultural possessions of our time. Enrollment limited. Fall: W. Kelley Spring: I. Lipkowitz

21L.003| Reading Fiction
---|---
Prereq: None
U (Fall, Spring)
3-0-9 HASS-D, Category 1, CI-H

Introduces prose narrative, both short stories and the novel. Examines the construction of narrative and the analysis of literary response. Enrollment limited. Fall: I. Lipkowitz Spring: S. Alexandre, R. Perry

21L.004| Reading Poetry
---|---
Prereq: None
U (Fall, Spring)
3-0-9 HASS-D, Category 1, CI-H


21L.005| Introduction to Drama
---|---
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 3, CI-H

A study of the history of theater art and practice from its origins to the modern period, including its roles in non-Western cultures. Special attention to the relationship between the literary and performative dimensions of drama, and the relationship between drama and its cultural context. Enrollment limited. Staff

21L.006| American Literature
---|---
Prereq: None
U (Fall, Spring)
3-0-9 HASS-D, Category 1, CI-H

Studies the national literature of the United States since the early 19th century. Considers novels, essays, films, and poems, focusing on efforts to define and reform a sense of American identity amidst increasing awareness of cultural diversity. Readings usually include works by Hawthorne, Thoreau, Frederick Douglass, Dickinson, Frost, Faulkner, Maxine Kingston, and Amy Tan. Enrollment limited. Fall: W. Kelley, N. Jackson Spring: J. Hildebidle

21L.007| World Literatures
---|---
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 1, CI-H

Introduces students to a coherent set of textual and visual materials drawn from different geographical regions, languages, artistic genres, and historical periods. The focus may vary but usually cuts across national boundaries. In-
cludes non-English works read in translation and examines different kinds of writing, both fiction and nonfiction. Pays special attention to such issues as identity formation, cultural contact, exploration, and exile. Previously taught topics include contemporary writing from Africa and South Asia, the impact of the discovery of the New World, and Caribbean literature.

M. Fuller

21L.008J Black Matters: Introduction to Black Studies
(Same subject as 2A.912J, SP.417J, 21A.114J, 21H.106J, 21M.630J, 21W.741J)
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 4, CI-H
See description under subject 21M.630J.
T. DeFrantz, S. Alexandre, C. Capozzola

21L.009 Shakespeare
Prereq: None
U (Fall, Spring)
3-0-9 HASS-D, Category 1, CI-H
Focuses on a close reading of six to eight of Shakespeare’s plays, as well as their adaptation for stage and/or film. Selected texts cover the range of genres in which Shakespeare wrote (i.e. history, comedy, tragedy, and romance). Plays vary between sections and from term to term, and have recently included Henry IV Part 1, Hamlet, A Midsummer Night’s Dream, King Lear, Twelfth Night, and The Tempest. Enrollment limited.
Fall: P. Donaldson, S. Raman
Spring: P. Donaldson

21L.011 The Film Experience
Prereq: None
U (Fall, Spring)
3-3-6 HASS-D, Category 3, CI-H
An introduction to narrative film, emphasizing the unique properties of the movie house and the motion picture camera, the historical evolution of the film medium, and the intrinsic artistic qualities of individual films. Syllabus changes from term to term, but usually includes such directors as Griffith, Chaplin, Renoir, Ford, Hitchcock, De Sica, and Fellini.
Fall: D. Thorburn
Spring: M. Marks

21L.012 Forms of Western Narrative
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 1, CI-H
Examines forms of storytelling that have developed in Western cultures from Homer to the present. Emphasis on literary and cultural issues; the emergence of different narrative genres and media; story forms as anthropological artifacts. Syllabus varies but usually includes folk tales, and authors such as Homer, Sophocles, Cervantes, Llaclos or Tolstoy, Poe, and at least one film.
J. Buzard

21L.013J The Supernatural in Music, Literature and Culture (New)
(Same subject as 21A.113J, 21M.013J)
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 3, CI-H
See description under subject 21M.013J.
C. Shadle, M. Fuller, J. Howe

21L.014J Empire: Introduction to Ancient and Medieval Studies (New)
(Same subject as 21H.007J)
Prereq: None
U (Fall)
3-0-9 HASS
See description under subject 21H.007J.
A. Bahr, W. Broadhead, E. Goldberg

21L.016 Learning from the Past: Drama, Science, Performance
(Subject meets with 21M.616)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS-D, Category 3, CI-H
Explores the creation (and creativity) of the modern scientific and cultural world through study of western Europe in the 17th century, the age of Descartes and Newton, Shakespeare, Milton and Ford. Compares period thinking to present-day debates about the scientific method, art, religion, and society. This team-taught, interdisciplinary subject draws on a wide range of literary, dramatic, historical, and scientific texts and images, and involves theatrical experimentation as well as reading, writing, researching and conversing.
D. Henderson, J. Sonenberg

21L.017 The Art of the Probable
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 2, CI-H
Examines literary texts and films in relation to the history of the idea of probability. Traces the growing importance of probability both as a measure of the reliability of ideas or beliefs and also as a basic property of things and the world. Connects the development and use of probabilistic reasoning (e.g., in the lottery, the insurance industry, and the stock market) with literary and cultural concerns regarding the rationality of belief, risk and uncertainty, free will and determinism, chance and fate. Discussion of the work of scientific and philosophical pioneers of probabilistic thought (e.g., Pascal, Leibniz, Bernoulli, Laplace, and Einstein) in conjunction with a variety of literary texts and films, including works of Shakespeare, Jane Austen, H. G. Wells, and classic Hollywood cinema.
A. Kibel, S. Raman

21L.310 Bestsellers
Prereq: None
U (Fall, Spring)
2-0-4
Can be repeated once for credit if content differs
Focuses on works that caught the popular imagination in the past or present. Emphasizes texts that are related by genre, theme or style. Books studied vary from term to term. Enrollment limited.
Fall: S. Tapscoot
Spring: W. Kelley

21L.315 Prizewinners
Prereq: None
U (Spring)
2-0-4
Can be repeated once for credit if works studied differ
Examines the work of major prize-winning writers or filmmakers. Texts and authors are chosen that have won such prestigious literary awards as the Nobel Prize, the Booker Prize, or the National Book Award, or films that have been feted at major international film festivals. Authors and works vary from term to term. Topic for Spring: Nobel laureates Derek Walcott and Seamus Heaney. Enrollment limited.
D. Thorburn

21L.320 Big Books
Prereq: None
U (Fall)
2-0-4
Can be repeated once for credit if works studied differ
Intensive study of a single major literary work or a very small set of related literary works. Emphasizes texts that encourage close analysis in a way that cannot easily be integrated into the regular literature curriculum. Content varies from term to term. Enrollment limited.
M. Fuller
**21L.325 Small Wonders**  
Prereq: None  
U (Fall)  
2-0-4  
Can be repeated once for credit if works studied differ  

Close examination of a coherent set of short texts and/or visual works. The selections may be the shorter works of one or more authors (poems, short stories or novellas), or short films and other visual media. Content varies from term to term. Enrollment limited.  
*J. Picker*

**21L.330 Latin I**  
Prereq: None  
U (Fall; first half of term)  
3-0-3  

Introduces rudiments of Latin to students with little or no prior knowledge of the subject. Aimed at laying a foundation to begin reading ancient and/or medieval literary and historical texts. Latin I and Latin II may be combined by petition (after completion of both) to count as a single HASS Elective. Enrollment limited to 20.  
*Staff*

**21L.335 Latin II**  
Prereq: 21L.330 or permission of instructor  
U (Fall; second half of term)  
3-0-3  

Introductory Latin subject for students with some prior knowledge of basic grammar and vocabulary. Intended to refresh and enrich ability to read ancient and/or medieval literary and historical texts. May be taken independently of Latin I with permission of instructor. Latin I and Latin II may be combined by petition (after completion of both) to count as a single HASS Elective. Enrollment limited to 20.  
*Staff*

### Intermediate Subjects

#### Genres and Themes

**See also SP.433.**

**21L.420 Literary Studies: The Legacy of England**  
Prereq: One subject in Literature  
U (Spring)  
3-0-9 HASS  

Examines English literature across genre and historical period. Designed for students who wish to study English literature or writing in some depth, or wish to know more about English literary culture and history. Learn about the relationships between literary themes, forms, and conventions and the times in which they were produced. Students examine Renaissance lyrics, Enlightenment satire, and modernist short stories. Focused on England because of its historical importance and its usefulness as an example for illustrating patterns over the centuries. Students form a framework for understanding how more focused subjects fit into literary studies, and what terms, concerns, and methods provide connections among the diverse subjects grouped under “literature.”  
*S. Tapscott*

**21L.421 Comedy**  
Prereq: None  
U (Fall, Spring)  
3-3-6 HASS-D, Category 1, CI-H  

Surveys a range of comic texts in different media, the cultures that produced them, and various theories of comedy. Authors and directors studied may include Aristophanes, Shakespeare, Molière, Austen, Wilde and Chaplin.  
*Fall: H. Eiland  
Spring: W. Kelley*

**21L.422 Tragedy**  
Prereq: None  
U (Spring)  
3-0-9 HASS  

Aspects of the tragic as a mode of literature and a quality of lived experience pursued in readings that extend from the warfare of the ancient world to the experiences of modern life. Authors include Aeschylus, Sophocles, Euripides, Shakespeare, Balzac, Tolstoy, Ibsen, Conrad, Dinesen, Faulkner, and Camus. Includes viewing of at least two films.  
*H. Eiland*

**21L.423 Folk Music of the British Isles and North America**  
(Same subject as 21M.223)  
Prereq: None  
U (Fall)  
3-1-8 HASS-D, Category 3, CI-H  

See description under subject 21M.223.  
*G. Ruckert, R. Perry*

**21L.430 Popular Narrative**  
(Subject meets with SP.492, CMS.920)  
Prereq: None  
U (Spring)  
3-3-6 HASS  

Can be repeated for credit with permission of instructor  

Examines the relationship between popular and high culture and the problem of evaluating texts that tell stories. Treats a range of narrative and dramatic works as well as films. Previously taught topics include Masterminds and Popular Culture in an Age of Media Convergence.  
*Staff*

**21L.432 Understanding Television**  
(Subject meets with CMS.915)  
Prereq: One subject in Literature or Comparative Media Studies  
Acad Year 2009–2010: U (Spring)  
Acad Year 2010–2011: Not offered  
3-3-6 HASS  

Can be repeated for credit  

A cultural approach to television’s evolution as a technology and system of representation. Considers television as a system of storytelling and mythmaking, and as a cultural practice studied from anthropological, literary, and cinematic perspectives. Focuses on primetime commercial broadcasting, the medium’s technological and economic history, and theoretical perspectives. Considerable television viewing and readings in media theory and cultural interpretation are required. Previously taught topics include American Television: A Cultural History. Meets with CMS.915, but assignments differ.  
*W. Uricchio*

**21L.433 Film Styles and Genres**  
Prereq: 21L.011 or permission of instructor  
U (Spring)  
3-3-6 HASS  

Can be repeated for credit with permission of instructor  

Close study of one or more directors, genres, periods, artistic movements, or national cinemas which have been of major significance in the history of film. Previously taught topics include Hollywood and Hong Kong, and Movie Realists: Chaplin, Renoir, Neorealism, Truffaut.  
*D. Thorburn*

**21L.434 Science Fiction and Fantasy**  
Prereq: None  
U (Spring)  
3-3-6 HASS  

Traces the history of science fiction as a generic tradition in literature, media, and popular culture. Considers formal ideological and cultural approaches to the analysis and interpretation of science fiction and fantasy texts.  
*Staff*
21L.435 Literature and Film
(Subject meets with CMS.840)
Prereq: One subject in Literature or Comparative Media Studies
U (Fall, Spring)
3-3-6 HASS
Can be repeated for credit

Investigates relationships between the two media, including film adaptations as well as works linked by genre, topic, and style. Explores how artworks challenge and cross cultural, political, and aesthetic boundaries. Previously taught topics include Shakespeare, Film and Media. Meets with CMS.840, but assignments differ.
Fall: P. Donaldson
Spring: Staff

21L.448 Darwin and Design
(Same subject as 21W.739)
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 2, CI-H

In The Origin of Species, Darwin provided a model for understanding the existence of objects and systems manifesting evidence of design without positing a designer, and of purpose and mechanism without intelligent agency. Texts deal with pre-Darwinian and later treatment of this topic within literature and speculative thought since the 18th century, with some attention to the modern study of feedback mechanism in artificial intelligence. Readings in Hume, Voltaire, Malthus, Darwin, Butler, Hardy, H. G. Wells, and Freud.
A. Kibel, J. Paradis

21L.449 Literature and the Environment
Prereq: None
U (Spring)
3-0-9 HASS

A brief history of conflicting ideas about mankind’s relation to the natural environment as exemplified in works of poetry, fiction, and discursive argument from ancient times to the present. Examines views about the overall character of the natural world and whether mankind’s relation to it is one of stewardship and care or hostility and exploitation. Readings include Aristotle, The Book of Genesis, Shakespeare, Descartes, Robinson Crusoe, Swift, Rousseau, Wordsworth, Darwin, Thoreau, Faulkner, and Lovelock’s Gaia.
A. Kibel

21L.450 The Ethics of Leadership
Prereq: One subject in Literature
U (Fall)
3-0-9 HASS

Examination of literary works to explore competing ethical concepts and the ethical implications of certain actions and commitments. Topics include origins of morality, ideals of justice, the nature of the virtues, notions of responsibility, ethics and politics, and the ethics of extreme situations. Philosophic texts by Plato, Aristotle, Machiavelli, Hobbes, and Kant. Narrative and dramatic texts by Sophocles, Euripides, Shakespeare, Swift, Ibsen, Shaw, Dostoyevsky, and Conrad, as well as some Biblical materials.
A. Kibel

21L.451 Introduction to Literary Theory
Prereq: None
U (Spring)
3-0-9 HASS

Examines the ways texts can be read and questions that readers ask of texts. Aims to provide students with a sense of the different critical approaches to literature. Topics include: structuralism and semiotics; post-structuralism and post-modernism; historicism and historicist paradigms; psychoanalysis; intertextuality; and cultural criticism.
S. Raman

21L.455 Classical Literature
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Can be repeated once for credit as long as specific topic is different

Explores the classical roots of Western civilizations through a close examination of the social and cultural contexts in which selected literary texts were first produced, the influence of political structures and ideologies, the function of rhetorical forms, the purpose and significance of ancient mythologies, and the relation of literature to shared developments in art, architecture, and religion. Texts taught in translation, but direct readings in the original languages are encouraged. Authors include Livy, Lucretius, Cicero, Julius Caesar, Virgil, Horace, and Ovid. Texts and topics vary from year to year. Enrollment limited.
Staff

21L.458 The Bible
Prereq: None
U (Fall)
3-0-9 HASS

An introduction to major books from both the Hebrew Bible and the New Testament. Particular attention given to literary techniques, issues resulting from translation from the original Hebrew and Greek, and the different historical periods that produced and are reflected in the Bible. Investigation of the Bible as influence in later narrative, philosophic, and artistic traditions.
I. Lipkowitz

Periods of World Literature

21L.460 Medieval Literature
(Subject meets with SP.514)
Prereq: One subject in Literature
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Can be repeated for credit

Surveys a range of literary works across different European cultures from the Roman Empire to the beginnings of the Renaissance. Literary movements and cultural developments discussed in their social, political, and historical contexts. Topics covered include the growth of religious communities, the shift from orality to literacy, the culture of chivalry and courtly love, the emergence of scholasticism and universities, changes in devotional practices and popular piety, religious intolerance and the Crusades, and the rise of nationalism and class consciousness. Previously taught topics include Medieval Women Writers, The Crusades, and Dante, Boccaccio and Chaucer. Enrollment limited.
A. Bahr

21L.463 Renaissance Literature
Prereq: One subject in Literature
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

Readings are organized around topics (Renaissance self-fashioning, courtship and courtiership, gender and the emerging individual) or literary genres (lyric, epic, drama, prose). Works drawn primarily from the Italian and English Renaissance, and may include such figures as Petrarch, Shakespeare, More, Jonson, Machiavelli, Castiglione, Milton, Spenser, Bacon, Donne, and Sidney. Previously taught topics include Renaissance Poetry and Strivers and Slackers. Enrollment limited.
M. Fuller
21L.470 Eighteenth-Century Literature  
Prereq: One subject in Literature  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Fall)  
3-0-9 HASS  
An examination of 18th-century English writers in their historical context. Authors James Thomson, Joseph Addison, Laurence Sterne, Mary Robinson, and Mary Wollstonecraft address issues of capitalism and class mobility; romantic love and the changing definition of femininity and masculinity; the mutual emergence of mass culture and of high-cultural aesthetics; and colonialism and international travel. Previously taught topics include Gods and Monsters: Versions of the Self in 18th-Century Britain. Staff.

21L.471 Major English Novels  
Prereq: One subject in Literature  
U (Spring)  
3-0-9 HASS  
Can be repeated for credit with permission of instructor.  
Studies important examples of the literary form that, between the beginning of the 18th century and the end of the 19th century, became an indispensable instrument for representing modern life, in the hands of such writers as Defoe, Richardson, Fielding, Sterne, Burney, Austen, Scott, Dickens, the Brontës, Eliot, Hardy, and Conrad. The class alternates between 18th- and 19th-century topics. J. Lipkowitz.

21L.472 Major European Novels  
Prereq: None  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Fall)  
3-0-9 HASS  

21L.473J Jane Austen  
(Same subject as SP.513J)  
Prereq: One subject in Literature  
U (Spring)  
3-0-9 HASS  
An examination of Jane Austen’s satire in her seven complete novels, several fragments, and juvenilia. Students read these texts in relation to her letters and other biographical and historical information. Instruction and practice in oral and written communication provided. Enrollment limited. R. Perry.

21L.476 Romantic Poetry  
Prereq: One subject in Literature  
U (Fall)  
3-0-9 HASS  
Close readings of the major British Romantic poets (Blake, Wordsworth, Coleridge, Byron, Scott, Shelley, and Keats) and important fiction writers (Mary Shelley and Walter Scott). Attention given to literary and historical contexts. N. Jackson.

21L.481 Victorian Literature and Culture  
Prereq: One subject in Literature  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Spring)  
3-0-9 HASS  
Can be repeated for credit.  
British literature and culture during Queen Victoria’s long reign, 1837–1901. Authors studied may include Charles Dickens, the Brontës, Lewis Carroll, George Eliot, Robert Browning, Oscar Wilde, Arthur Conan Doyle, Rudyard Kipling, and Alfred Lord Tennyson. Discussion of many of the era’s major developments such as urbanization, steam power, class conflict, Darwin, religious crisis, imperial expansion, information explosion, and bureaucratization. Fiction, nonfiction, and poetry; syllabi vary. Staff.

21L.485 Modern Fiction  
Prereq: One subject in Literature  
U (Fall)  
Units arranged HASS  
Tradition and innovation in representative fiction of the early modern period. Recurring themes include the role of the artist in the modern period; the representation of psychological and sexual experience; and the virtues (and defects) of the aggressively experimental character. Works by Conrad, Kipling, Babel, Kafka, James, Lawrence, Mann, Ford Madox Ford, Joyce, Woolf, Faulkner, and Nabokov. Students register for 9 or 12 units of credit, depending on the intensity of the writing assignments. Contact the professor to determine appropriate units. D. Thorburn.

21L.486 Modern Drama  
Prereq: One subject in Literature  
Acad Year 2009–2010: U (Spring)  
Acad Year 2010–2011: Not offered  
3-0-9 HASS  

21L.487 Modern Poetry  
Prereq: One subject in Literature  
U (Fall)  
3-0-9 HASS  

21L.488 Contemporary Literature  
Prereq: One subject in Literature  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Spring)  
3-0-9 HASS  
Study of key themes and techniques in prose, poetry, and drama since the 1970s. Recent topics include postmodernism, globalization, new British and Irish writing, and literature and development. Staff.

21L.489J Interactive and Non-Linear Narrative: Theory and Practice  
(Same subject as 21W.765J)  
(Subject meets with CMS.845)  
Prereq: None  
U (Fall)  
3-0-9 HASS  
See description under subject 21W.765J. N. Montfort.

American Literature  
See also 21L.006.

21L.501 The American Novel  
Prereq: None  
U (Fall)  
3-0-9 HASS  
Works by major American novelists, beginning with the late 18th century and concluding with a contemporary novelist. Major emphasis on reading novels as literary texts, but attention paid to historical, intellectual, and political contexts as well. Syllabus varies from term to term, but many of the following writers are represented:
Rowson, Hawthorne, Melville, Twain, Wharton, James, and Toni Morrison. Previously taught topics include “The American Revolution” and “Makeovers” (i.e. adaptations and reinterpretation of novels traditionally considered as American “Classics”). Enrollment limited.

S. Alexandre

21L.504 Race and Identity in American Literature
(Same subject as SP.518)
Prereq: None
U (Spring)
3-0-9 HASS

Questions posed by the literature of the Americas about the relationship of race and gender to authorship, audience, culture, ethnicity, and aesthetics. Social conditions and literary histories that shape the politics of identity in American literature. Specific focus varies each term. Previously taught topics include Cultural Encounters from 1492 to the Civil War, Immigrant Stories, African American Literature, and Asian American Literature.

S. Alexandre

21L.512 American Authors
(Subject meets with SP.517)
Prereq: One subject in Literature
U (Fall)
3-0-9 HASS

Examine in detail the works of several American authors selected according to a theme, period, genre, or set of issues. Through close readings of poetry, novels, or plays, subject addresses such issues as literary influence, cultural diversity, and the writer’s career. Previously taught topics include American Women Writers, Hemingway, and American Short Fiction.

W. Kelley

21L.704 Studies in Poetry
Prereq: Two subjects in Literature
U (Fall, Spring)
3-0-9 HASS
Can be repeated for credit


Fall: S. Tapscott
Spring: M. Fuller

21L.705 Major Authors
(Subject meets with SP.512)
Prereq: Two subjects in Literature
U (Fall, Spring)
3-0-9 HASS
Can be repeated for credit

Close study of a limited group of writers. Instruction and practice in oral and written communication. Previously taught topics include John Milton and his Age, Chaucer, Herman Melville, Toni Morrison, and Oscar Wilde and the ’90s. Enrollment limited to 12.

Fall: J. Picker
Spring: W. Kelley

21L.706 Studies in Film
(Subject meets with CMS.830)
Prereq: 21L.011 and one subject in Literature or Comparative Media Studies; or permission of instructor
U (Spring)
3-3-6 HASS
Can be repeated for credit

Intensive study of films of a particular period or genre, or films by a single director. Instruction and practice in oral and written communication. Meets with CMS.830, but assignments differ. Previously taught topics include Technologies of Seeing: Pre-Cinema to Early Cinema, Hollywood/Bollywood, Film Analysis and Shakespeare on Film.

R. Donaldson

21L.707 Problems in Cultural Interpretation
Prereq: Two subjects in Literature or permission of instructor
U (Fall)
3-0-9 HASS
Can be repeated for credit

Studies the relation between imaginative texts and the culture surrounding them. Emphasizes ways in which imaginative works absorb, reflect, and conflict with reigning attitudes and world views. Instruction and practice in oral and written communication. Previously taught topics include Women Reading/Women Writing, Poetry, Passion, and the Self, Arthurian Literature and the Colonization of the Celts, and Race, Religion and Identity in Early Modern America. Enrollment limited to 12.

S. Raman
21L.708 Literature and Technology
(Subject meets with CMS.910)
Prereq: Two subjects in Literature and/or Comparative Media Studies or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Can be repeated for credit
Examines the relationship between literary or artistic artifacts and the particular technologies through which they were produced and disseminated. In what ways do the actual technical practices of composition affect the nature of what is produced? How are artistic works influenced by the emergence of new technical possibilities and processes? Topics studied vary from term to term. Previously taught topics include the emergence of hypertexts and hyper-realities; Shakespeare across media; and the effect of the printing press on the development of Renaissance humanism.
Staff

21L.709 Studies in Literary History
Prereq: Two subjects in Literature or History
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Can be repeated for credit
Close examination of the literature of a particular historical period. Syllabi vary. Instruction and practice in oral and written communication. Enrollment limited to 12.
Staff

21L.715 Media in Cultural Context
(Subject meets with SP.493, CMS.871)
Prereq: Two subjects in Literature and/or Comparative Media Studies, or permission of instructor
U (Fall, Spring)
3-3-6 HASS
Can be repeated for credit
Seminar designed to provide close case study examinations of specific media or media configurations and the larger social, cultural, economic, political, or technological contexts within which they operate. Subject organized around recurring themes in media history, specific genres or movements, specific media, or specific historical moments. Instruction and practice in written and oral communication provided. Previously taught topics include Gendered Genres: Horror and Maternal Melodramas, Comics, Cartoons, and Graphic Storytelling, and Exploring Children's Culture. Meets with CMS.871, but assignments differ. Limited to 12.

Fall: Staff
Spring: J. Picker

21L.993 Special Topics: Studies in Poetry—Latin
Prereq: None
U (Spring)
3-0-9
Intensive study of the classical Latin poetic tradition. Substantial readings in the original text. Additional primary texts and all secondary texts read in English. Suitable for students who have taken 21L.330 and 21L.335, and those with previous training in Latin. Enrollment limited to 12.
Staff

21L.994 IAP Special Topics in Literature
Prereq: None
U (IAP)
Units arranged
Can be repeated for credit if topics are different
21L.995 IAP Special Topics in Literature
Prereq: None
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit if topics are different
Units vary depending on the term’s content, number of class meetings, readings and assignments. Maximum credit of 6 units. Consult IAP listing for detailed descriptions and current topics. Contact instructor to determine assignment differences between 21L.994 and 21L.995.
Staff

21L.996, 21L.997 Topics in Film and Media
Prereq: Two subjects in Film and Media; permission of director of Comparative Media Studies
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit with permission of instructor
Open to qualified students who wish to pursue special projects with film and media studies faculty. Individual or small group projects encouraged. Usually limited to 6 credits.
Staff

21L.998, 21L.999 Special Topics in Literature
Prereq: Two subjects in Literature; permission of Literature Faculty Chair
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit with permission of instructor
Open to qualified students who wish to pursue special studies or projects with members of the Literature faculty. Normal maximum is 6 units, though exceptional 9-unit projects are occasionally approved.
Staff

21L.ThU Literature Pre-Thesis Tutorial
Prereq: None
U (Fall, Spring)
1-0-5
Can be repeated for credit
Definition of and early-stage work on thesis project leading to 21L.ThU. Taken during the first term of the student’s two-term commitment to the thesis project. Student works closely with an individual faculty tutor. Required for students in Course 21L when the thesis is a degree requirement.
Staff

21L.ThU Literature Thesis
Prereq: 21L.ThT
U (Fall, Spring)
Units arranged
Can be repeated for credit
Completion of work on the senior major thesis under supervision of a faculty tutor. Includes oral presentation of thesis progress early in the term, assembling and revising the final text, and meeting at the close with a committee of faculty evaluators to discuss the successes and limitations of the project. Required for students in Course 21L when the thesis is a degree requirement.
Staff

21L.UR Undergraduate Research
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
21L.URG Undergraduate Research
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit
Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program. Consult J. Buzard

For individual research in Literature, register for 21L.UR or 21L.URG. For Literature pre-thesis tutorial, register for 21L.ThT. For undergraduate thesis, register for 21L.ThU. Descriptions of these subjects can be found in the beginning of this section under 21L.UR, 21L.URG, 21L.ThT, and 21L.ThU.
Bachelor of Science in Literature/Course 21L

General Institute Requirements (GIRs)  
Subjects
Science Requirement 6
Humanities, Arts, and Social Sciences Requirement [three subjects can be satisfied by subjects in the Departmental Program] 8
Restricted Electives in Science and Technology (REST) Requirement 2
Laboratory Requirement 1
Total GIR Subjects Required for SB Degree 17

Communication Requirement
The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program
Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

Required Subjects
Units
Three seminar level subjects 36
To satisfy the requirement that students complete two Communication Intensive subjects in the major, students must take two subjects from this list of approved CI-M subjects for Course 21L: 21L.473J, 21L.701, 21L.702, 21L.703, 21L.704, 21L.705, 21L.706, 21L.707, 21L.708, 21L.709.

Note: Four of the 10 subjects required to satisfy the major (three of the eight for joint majors) must be chosen, in consultation with a faculty advisor, either from four of five historical periods (ancient/modern; Renaissance; Restoration and 18th century; 19th century; 20th century and contemporary) or from four of five thematic complexes (historical period; genre; author study; film, media, and popular culture; gender studies, ethnic studies, and theory).

Restricted Electives
Units
A coherent program of seven additional subjects from the literature curriculum (see above). 63–84

Departmental Program Units That Also Satisfy the GIRs
Units
(27–36)

Unrestricted Electives
Units
87–117

Total Units Beyond the GIRs Required for SB Degree
Units
180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes
For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
MUSIC

The Music subjects described below are grouped within six areas: Introductory, History/Literature, Theory/Composition, Performance, Special Topics/Advanced Subjects, and Music and Media.

Although most students start with introductory subjects, those who have vocal or instrumental training or extensive exposure to music are encouraged to begin at a higher starting level.

Introductory Subjects

21M.011 Introduction to Western Music
Prereq: None
U (Fall, Spring)
4-0-8 HASS-D, Category 3, CI-H

Gives students a broad overview of Western music from the Middle Ages to the 20th century, with emphasis on late baroque, classical, romantic, and modernist styles. Enhances the musical experience by developing listening skills and an understanding of diverse forms and genres. Major composers and works placed in social and cultural contexts. Weekly lectures feature demonstrations by professional performers, and introduce topics to be discussed in sections. Enrollment may be limited.

Fall: M. Marks, T. Neff
Spring: L. Lindgren, T. Neff

21M.013] The Supernatural in Music, Literature and Culture
(Same subject as 21A.113, 21L.013)
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 3, CI-H

Explores the relationship between music and the supernatural, focusing on the social history and context of supernatural beliefs as reflected in key literary and musical works from 1600 to the present. Provides a better understanding of the place of ambiguity and the role of interpretation in culture, science and art. Explores great works of art by Shakespeare, Verdi, Goethe (in translation), Gounod, Henry James and Benjamin Britten. Readings will also include selections from the most recent scholarship on magic and the supernatural. Writing assignments will range from web-based projects to analytic essays. No previous experience in music is necessary. Projected guest lectures, musical performances, field trips.

C. Shadle, M. Fuller, J. Howe

21M.030 Introduction to World Music
Prereq: None
U (Fall, Spring)
3-0-9 HASS-D, Category 3, CI-H

An introduction to diverse musical traditions of the world. Music from a wide range of geographical areas is studied in terms of structure, performance practice, social use, aesthetics, and cross-cultural contact. Includes hands-on music making, live demonstrations by guest artists, and ethnographic research projects.

Staff

21M.051 Fundamentals of Music
Prereq: None
U (Fall, Spring)
3-3-6 HASS

Introduces students to the rudiments of Western music through oral, aural, and written practice utilizing rhythm, melody, intervals, scales, chords, and musical notation. Individual skills are addressed through a variety of approaches, including keyboard practice in the required piano labs. Students who have already taken 21M.301 or 21M.302 may not enroll in 21M.051.

P. Wood

21M.065 Introduction to Musical Composition
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 3

Through a progressive series of composition projects, students investigate the sonic organization of musical works and performances, focusing on fundamental questions of unity and variety. Aesthetic issues are considered in the pragmatic context of the instructions that composers provide to achieve a desired musical result, whether these instructions are notated in prose, as graphic images, or in symbolic notation. No formal training is required. Weekly listening, reading, and composition assignments draw on a broad range of musical styles and intellectual traditions, from various cultures and historical periods.

K. Makan

History/Literature

21M.215 American Music
Prereq: Permission of instructor
Acad Year 2009-2010: Not offered
Acad Year 2010-2011: U (Fall)
3-0-9 HASS

A survey of music in the United States from the colonial period to the present in the context of American cultural history, with an emphasis on Boston’s musical life whenever feasible. Listening and writing assignments concern classical, popular, folk, musical theater, and jazz repertoires.

M. Harvey

21M.220 Early Music
Prereq: 21M.011, 21M.301, or permission of instructor
U (Spring)
3-0-9 HASS

Studies the development of European vocal and instrumental music from the early Middle Ages until the late seventeenth century. Focuses primarily on chant and its development, music in Italy 1340-1440, English music at the end of the Renaissance, and Venice at the dawn of the Baroque era. Surveys additional topics that fall between these topics. Assignments, performance projects, and (especially) presentations explore lives, genres, and works in depth. Students study works in facsimiles of original notation where possible. Covers Wipo, Hildegard, “Anonymous,” Perotin, Machaut, Francesco da Firenze, Ciconia, Zachara, Du Fay, Josquin, Morley, Byrd, Dowland, Monteverdi, Gabrieli, and Schütz. Requires some score-reading ability.

M. Marks
21M.223J Folk Music of the British Isles and North America
(Same subject as 21L.423J)
Prereq: None
U (Fall)
3-1-8 HASS-D, Category 3, CI-H
Examines the production, transmission, preservation and the qualities of folk music in the British Isles and North America from the 18th century to the folk revival of the 1960s and the present. Special emphasis on balladry, fiddle styles, and African-American influences.
G. Ruckert, R. Perry

21M.226 Jazz (21M.026)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-D, Category 3
Historical survey from roots in African and American contexts, including spirituals, blues, and ragtime, through early jazz, Swing, bebop, and post-bop movements, with attention to recent developments. Key jazz styles, the relation of music and society, and major figures such as Armstrong, Ellington, Basie, Goodman, Parker, Monk, Mingus, Coltrane, and others are considered. Some investigation of cross-influences with popular, classical, folk, and rock musics. Enrollment may be limited.
M. Harvey

21M.230 Vivaldi, Bach, and Händel
Prereq: None
U (Fall)
3-0-9 HASS, CI-H
Listening assignments sample all genres composed by the three great masters and by four significant contemporaries. Reading assignments concern the structural, textural and performance aspects of music and trace contemporary intellectual, artistic and social changes. Four written essays and four oral presentations are based on assigned listening, reading, and live performances. Knowledge of score reading strongly recommended. Requires attendance at two or three performances. Enrollment limited.
L. Lindgren

21M.240 Haydn, Mozart, and Beethoven
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS
Listening assignments sample all genres composed by the three great masters and by a few notable contemporaries. Reading assignments regard structural, textural and performance aspects, and place the music within its cultural context. Four written essays and three oral presentations concern the assigned repertoire and two or three performances. Requires some knowledge of score-reading. Enrollment limited.
T. Neff

21M.250 Schubert to Debussy
Prereq: Permission of instructor
U (Fall)
3-0-9 HASS
A survey of developments in Western musical style, 1815–1915. Works by 35 composers, including the romantics: Schubert, Chopin, and Schumann; the post-romantics: Wagner, Verdi, and Brahms; the turn-of-the-century: Mahler, Debussy, and Ravel; and the Americans: Gottschalk, Beach, and Joplin. Score-reading ability is beneficial.
C. Shadle

21M.252 Song
Prereq: None
U (Spring)
3-0-9 HASS
A history of song from the time of Shakespeare to the present, examining ways in which individual composers of different periods and nationalities have responded to great poetry. Songs examined are chosen from a variety of composers, such as Schubert, Debussy, and Stravinsky, and studied in close connection with their texts, which include poetry by Shakespeare, Milton, Goethe, and Verlaine. Performing experience is welcomed but not required. Required reading, listening, and writing assignments. Ability to read music required. Enrollment limited.
E. Harris

21M.262 Modern Music: 1900–1960
Prereq: Ability to read music
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
A survey of major works by European and American composers spanning the first six decades of the 20th century. Central topics include modernism, tonality and atonality, and the impact of politics and new media. Considers composers in-depth, including Stravinsky, Copland, Shostakovich, and Cage.
M. Marks

21M.263 Music Since 1960
Prereq: One subject in music or permission of instructor
U (Spring)
3-0-9 HASS
Studies the musical world of the recent past, focusing on the continuing impact and transformation of classical music through close listening and presentation of important musical works. Topics include the year 1967; the rise of minimalism and “accessible” styles; postmodernism; computers, video games, and electronic music; texture and instrumentation (including spectral composition); text, narrative, and multimedia; improvisational and performance arts; popular music analysis; postserial process; and how to study the music of today. Places particular emphasis on works by MIT composers.
E. Ziporyn

21M.271 Symphony and Concerto
Prereq: Permission of instructor
U (Fall)
3-0-9 HASS
Listening assignments include 28 symphonies and 28 concertos, composed from the 1720s to the present. Class discussion and oral presentations focus on the works in 16 miniature scores. Each of the three written papers reviews a concert attended during the term.
L. Lindgren

21M.273 Opera
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Focus on the text, music, and staging of 43 works by 25 composers, including 17 by Mozart, Wagner, and Verdi. Live performances are the primary basis for four written papers. Works composed during the last 125 years are the basis for two oral presentations. Enrollment limited.
L. Lindgren

21M.283 Musicals of Stage and Screen
Prereq: One subject in film, music, or theater; or permission of instructor
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9 HASS
Covers Broadway works and Hollywood films in depth. Proceeds chronologically, exploring three stage musicals and three films at a time, within four historical categories: breakthrough musicals of the 1920s and ’30s; classic “book musicals” of the ’40s and ’50s; modernist and concept musicals of the ’60s and ’70s; and post modern and cutting-edge works of the ’80s and ’90s. Attention given to the role of music in relation to script, characterization, and dramatic structure. Final papers involve comparison of one stage and one film work, selected in con-
sultation with the instructor. Oral presentations required and in-class performances encouraged.  

**M. Marks**

**21M.284 Film Music**  
(Subject meets with CMS.925)  
Prereq: None  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Spring)  
3-3-6 HASS

Surveys styles and dramatic functions of music for silent films of the 1910s–1920s, and music in sound films from the 1930s to the present. Close attention given to landmark scores by American and European composers, including Korngold, Steiner, Rozsa, Prokofiev, Copland, Herrmann, Rota, Morricone, and Williams. Subsidiary topics include new trends in contemporary film-scoring, pop scores, the impact of electronics, and specialized genres (e.g., animation). Students taking the graduate version complete different assignments. Some background in the study of film and/or music is expected.  

**M. Marks**

**21M.291 Music of India**  
Prereq: None  
U (Spring)  
3-0-9 HASS

Focuses on Hindustani classical music of North India, and also involves learning about the ancient foundations of the rich classical traditions of music and dance of all Indian art and culture. Practice of the ragas and talas through the learning of songs, dance, and drumming compositions. Develops insights through listening, readings, and concert attendance.  

**G. Ruckert**

**21M.292 Music of Indonesia**  
Prereq: None  
U (Spring)  
2-2-8 HASS

Provides an introduction to the fascinating, intricate music of Indonesia. The Indonesian archipelago is home to a wide variety of cultures and musical traditions, many of them largely unknown in the West. From the Gamelan percussion orchestras of Bali and Java to the indigenous folk traditions of Sumatra and Borneo, and Western-influenced pop and street traditions.  

**E. Ziporyn**

**21M.293 Music of Africa**  
Prereq: None  
U (Fall)  
3-0-9 HASS

Focuses on musical traditions of West Africa. A variety of musical practices and their cultural contexts are explored through listening, reading and writing assignments with an emphasis on class discussion. Subject includes in-class instruction in Senegalese drumming, song and dance, as well as live lecture-demonstrations by guest performers from throughout West Africa.  

**P. Tang**

**21M.294 Popular Musics of the World**  
Prereq: None  
U (Spring)  
3-0-9 HASS

Focuses on popular music created for and transmitted by mass media. Various popular music genres from around the world are studied through listening and reading assignments, while considering issues of musical change, syncretism, Westernization, globalization, the impact of recording industries, and the post-colonial era. Case studies include bhangra, Afro-pop, reggae, and global hip-hop.  

**P. Tang**

**21M.295 American Popular Music (New)**  
Prereq: None  
U (Spring)  
3-0-9 HASS

Surveys the development of popular music in the US, and in a cross-cultural milieu, relative to the history and sociology of the last two hundred years. Examines the ethnic mixture that characterizes modern music, and how it reflects many rich traditions and styles (minstrelsy, music-hall, operetta, Tin Pan Alley, blues, rock, electronic media, etc.). Provides a background for understanding the musical vocabulary of current popular music styles.  

**G. Ruckert**

**Theory/Composition**

**21M.301 Harmony and Counterpoint I**  
Prereq: 21M.302 or permission of instructor  
U (Fall, Spring)  
3-3-6 HASS-D, Category 3

Basic writing skills in music of the common-practice period (Bach to Brahms). Work includes regular written assignments leading to the composition of short pieces, analyzing representative works from the literature, keyboard laboratory, and sight-singing choir. It is recommended that entering students have some concert music listening or playing background. Enrollment may be limited.  

**Fall:** E. Ruehr, J. Matheson, G. Ruckert, C. Shadle, G. Saraydarian  
**Spring:** M. Harvey, E. Ruehr, G. Ruckert, M. Cuthbert, G. Saraydarian

**21M.302 Harmony and Counterpoint II**  
Prereq: 21M.301  
U (Fall, Spring)  
3-2-7 HASS

A continuation of 21M.301, including chromatic harmony and modulation, a more extensive composition project, keyboard laboratory, and musicianship laboratory.  

**Fall:** C. Hughes, P. Wood, G. Saraydarian  
**Spring:** C. Shadle, C. Hughes, P. Wood, G. Saraydarian

**21M.303 Writing in Tonal Forms I**  
Prereq: 21M.302  
U (Fall, Spring)  
3-1-8 HASS

Written and analytic exercises based on 18th- and 19th-century small forms and harmonic practice found in music such as the chorale preludes of Bach; minuets and trios of Haydn, Mozart, and Beethoven; and the songs and character pieces of Schubert and Schumann. Musicianship laboratory is required.  

**Fall:** C. Shadle, P. Wood, G. Saraydarian  
**Spring:** P. Child, P. Wood, G. Saraydarian

**21M.304 Writing in Tonal Forms II**  
Prereq: 21M.303  
U (Spring)  
3-1-8 HASS

Further written and analytic exercises in tonal music, focusing on larger or more challenging forms. For example, students might compose a sonata-form movement for piano or a two-part invention in the style of Bach. Students have opportunities to write short works that experiment with the expanded tonal techniques of the late 19th and early 20th centuries. Musicianship laboratory is required.  

**P. Child, P. Wood, G. Saraydarian**

**21M.310 Techniques of Twentieth-Century Composition**  
Prereq: 21M.302 or permission of instructor  
U (Fall)  
3-1-8 HASS

Written and analytical exercises based on 20th-century compositional forms and practices. Three areas to be covered include: compositions based upon artificial scales and modes, as in
Debussy, Bartok, Stravinsky; compositions based on atonal pitch organizations as with Schoenberg, Webern, Boulez; instructor’s choice of compositions based on rhythmic process, timbral exploration, or non-Western influences. Each composition will be written for a different solo instrument (piano for modal composition, wind for set theory composition, non-pitched percussion for rhythmic process composition, and strings for timbre-based composition). Basic instrumentation will be taught, and compositions will be performed in class. Enrollment limited.

K. Makan

21M.340 Jazz Harmony and Arranging
Prereq: 21M.051, 21M.026 or permission of instructor
U (Spring)
3-0-9 HASS

Basic harmony and theory of mainstream jazz and blues; includes required listening in jazz, writing and analysis work, and two full-scale arrangements. Serves as preparation for more advanced work in jazz with application to rock and pop music. Performance of student arrangements.

M. Harvey

21M.341 Jazz Composition
Prereq: 21M.026, 21M.340, or permission of instructor
U (Fall)
3-0-9 HASS

Jazz writing using tonal, modal, and extended compositional approaches as applied to the blues, the 32-bar song form, and post-bop structural designs. Consideration given to a variety of styles and to the ways improvisation informs the compositional process. Study of works by Ellington, Mingus, Parker, Russell, Evans, Nelson, Golson, Coleman, Coltrane, Threadgill, Hemphill, and others. Performance of student compositions.

M. Harvey

21M.342 Composing for Jazz Orchestra
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

Explores composition and arrangement for the large jazz ensembles from 1920s foundations to current postmodern practice. Consideration given to a variety of styles and to the interaction of improvisation and composition. Study of works by Basie, Ellington, Evans, Gillespie, Golson, Mingus, Morris, Nelson, Williams, and others. Open rehearsals, workshops, and performances of student compositions by the MIT Festival Jazz Ensemble and the Aardvark Jazz Orchestra.

M. Harvey

21M.350 Musical Analysis
Prereq: 21M.302 or permission of instructor
U (Spring)
3-0-9 HASS

An introduction to the analysis of tonal music. Students develop analytical techniques based upon concepts learned in 21M.301–21M.302. Students study rhythm and form, harmony, line and motivic relationships at local and large scale levels of musical structure. Three papers (totaling 20 pages, one to be revised) and one oral presentation required.

P. Child

21M.351 Music Composition
Subject meets with 21M.595
Prereq: 21M.304, 21M.310, or permission of instructor
U (Spring)
3-0-9 HASS

Can be repeated for credit

Directed composition of original writing involving voices and/or instruments. Includes a weekly seminar in composition for the presentation and discussion of work in progress. Students are expected to produce at least one substantive work and perform it in public by the end of the term. Contemporary compositions and major works from 20th-century music literature are studied. Students taking the graduate version complete different assignments.

K. Makan

21M.355 Musical Improvisation (New)
Prereq: Permission of instructor
U (Fall, Spring)
3-0-9 HASS

Can be repeated for credit with permission of instructor

Students study improvisation techniques in solo and ensemble contexts, culminating in one or more public performances. Examines relationships between improvisation, composition, and performance from a score. Topics, with occasional guest lectures, may include jazz, non-western music, and improvisation in western concert music. Open by audition to instrumental or vocal performers. Enrollment may be limited.

D. Fox

21M.361 Electronic Music Composition I
Prereq: None
U (Fall, Spring)
2-1-9 HASS

Explores sound and what can be done with it. Sources are recorded from students’ surroundings—sampled and electronically generated (both analog and digital). Assignments include composing with the sampled sounds, feedback, and noise, using digital signal processing (DSP), convolution, algorithms, and simple mixing. Focuses on sonic and compositional aspects rather than technology, math, or acoustics, though these are examined in varying detail. Weekly composition and listening assignments; material for the latter is drawn from sound art, experimental electronics, conventional and non-conventional classical electronic works, popular music, and previous students’ compositions. Enrollment limited to 10; preference to Music majors, minors, and concentrators.

P. Whincop

21M.362 Electronic Music Composition II (New)
Prereq: 21M.361 or permission of instructor
U (Spring)
2-2-8 HASS

Explores sophisticated synthesis techniques, from finely tuned additive to noise filtering and distortion, granular synthesis to vintage emulation. Incorporates production techniques and multimedia with guest lecturers/performers. Considers composing environments such as Max/MSP, SPEAR, SoundHack, and others. Assignments include diverse listening assignments with verbal presentations, weekly studies, critiques, and modular compositions. Intended for students with significant computer music experience. Consult instructor for computing requirements. Enrollment limited.

P. Whincop

21M.380 Music and Technology (New)
Prereq: Permission of instructor
U (Fall, Spring)
3-0-9 HASS

Can be repeated for credit

Explores various technologies in relation to musical analysis, composition, performance, culture, and quantitative methods. Topics vary each term and may include development and impact on society, generative and algorithmic music, or recording techniques. May involve hands-on components such as a laptop music ensemble, new instrument building, or comparing the theory and practice of audio recording.

C. Ariza
Performance

Each of the following subjects earns 6 units. A total of 12 units is needed for a subject to count toward Institute Requirements in Humanities, Arts, and Social Sciences, by petition to the Committee on Curricula.

21M.401 MIT Concert Choir
Prereq: None
U (Fall, Spring)
0-4-2
Can be repeated for credit
Rehearsals and performance of primarily large-scale works for chorus, soloists, and orchestra—primarily from the Passions and Masses of J. S. Bach to oratorios of our own time. Open to graduate and undergraduate students by audition.
W. Cutter

21M.405 MIT Chamber Chorus
Prereq: None
U (Fall, Spring)
3-0-3
Can be repeated for credit
Rehearsal and performance of choral repertoire for small chorus, involving literature from the Renaissance to contemporary periods. Membership limited to 32 students by audition.
W. Cutter

21M.410 Vocal Repertoire and Performance
(Subject meets with 21M.515)
Prereq: None. Coreq: Participation in ensemble for vocalists
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-3
Can be repeated for credit
For the singer and/or pianist interested in collaborative study of solo vocal performance. Historical study of the repertoire includes listening assignments of representative French, German, Italian, and English works as sung by noted vocal artists of the genre. Topics include diction as facilitated by the study of the International Phonetic Alphabet; performance and audition techniques; and study of body awareness and alignment through the Alexander Technique and yoga. Admission by auditions. Emerson Vocal Scholars contact department.
P. Wood

21M.421 MIT Symphony
Prereq: None
U (Fall, Spring)
0-4-2
Can be repeated for credit
Rehearsals prepare works for concerts and recordings. Analyses of musical style, structure, and performance practice are integrated into rehearsals as a means of enriching musical conception and the approach to performance. Likewise, additional scores of particular structural or stylistic interest are read whenever time permits. Admission by audition.
A. Boyles

21M.422 MIT Chamber Orchestra
Prereq: Permission of instructor
U (Fall, Spring)
0-2-1
Can be repeated for credit
Focuses on works from all eras of music history that require a smaller ensemble, unique instrumentation, or collaborative projects such as musical theater, choral works, and opera. Students delve into musical considerations beyond basic execution, including score study, composer research, and historically-informed performance practice. Rehearsals culminate in on- and off-campus performances. Restricted to MITSO or Chamber Music members by audition.
A. K. Boyles

21M.423 Conducting and Score-Reading
Prereq: 21M.301, 21M.302, or permission of instructor
U (Fall)
3-4-5 HASS
Introduces ensemble conducting as a technical and artistic discipline. Incorporates ear training, score-reading skills and analysis, rehearsal technique, and studies of various philosophies. Attendance of rehearsals and specific concerts required. Opportunities include conducting students, professional musicians, and MIT Symphony Orchestra (when possible). Instrumental proficiency required, although vocalists with keyboard abilities will be accepted.
A. Boyles

21M.426 MIT Wind Ensemble
Prereq: None
U (Fall, Spring)
0-4-2
Can be repeated for credit
Open by audition to advanced instrumentalists who are committed to the analysis, performance, and recording of woodwind, brass, and percussion literature from the Renaissance through the 21st century. The repertoire consists primarily of music for small and large wind ensembles. May include ensemble music from Gabrieli to Grainger, Schuller, Mozart, Dvorak, and various mixed media including strings. Performance of newly commissioned works. Opportunities for solo work.
Fall: K. Amis
Spring: F. Harris

21M.442 MIT Festival Jazz Ensemble
Prereq: None
U (Fall, Spring)
0-4-2
Can be repeated for credit
Open by audition to instrumentalists dedicated to the analysis and performance of traditional and contemporary jazz ensemble compositions. Instrumentation includes saxophones, trumpets, trombones, piano, guitar or vibraphone, bass, percussion and occasionally french horn, double reeds, and strings. Experience in improvisation preferred but not required. Opportunities to work with professional jazz artists and perform commissioned works by recognized jazz composers.
Fall: M. Harvey
Spring: F. Harris

21M.445 Chamber Music Society
Prereq: None
U (Fall, Spring)
0-4-2
Can be repeated for credit
Study of chamber music literature through analysis, rehearsal, and performance. Weekly seminars and coaching. Open to string, piano, brass, woodwind players, and singers. By audition.
Fall: D. Deveau, J. Rife, F. Harris, J. Harbison
Spring: M. Thompson, D. Deveau, J. Rife, F. Harris

21M.450 MIT Balinese Gamelan
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall, Spring)
0-3-3
Can be repeated for credit
A performing ensemble dedicated to the traditional music of Bali and East Java. Members of the ensemble rehearse and study techniques on MIT’s three distinctive sets of gamelan instruments and perform in conjunction with Gamelan Galak Tika. No previous experience necessary, but prior enrollment in 21M.030 or 21M.292 is strongly recommended. Enrollment limited to 25 students by audition.
E. Ziporyn
21M.451 Studio Accompanying for Pianists
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit

Open by audition to pianists who wish to explore and develop their talents as accompanists. Pianists are paired with a music scholarship recipient and attend that student’s private lesson each week. Accompanists prepare independently, rehearse with the student partner, and provide accompaniment at a juried recital or masterclass each term. Under supervision for music faculty and private lesson instructors, pianists may work with one or two scholarship students each term at 3 units each or one student in 21M.480/21M.512 for 6 units. Subject satisfies the performance requirement for pianists receiving music scholarships.

D. Deveau

21M.460 MIT Senegalese Drum Ensemble
Prereq: None
U (Fall, Spring)
0-3-3
Can be repeated for credit

A performance ensemble focusing on the sabar drumming tradition of Senegal, West Africa. Study and rehearse Senegalese drumming techniques and spoken word. Perform in conjunction with MIT Rambax drumming group. No previous experience necessary, but prior enrollment in 21M.030 or 21M.293 strongly recommended. Enrollment limited to 20 students by audition.

L. Toure

21M.480 Advanced Music Performance
(Subject meets with 21M.512)
Prereq: None
U (Fall, Spring)
1-2-3
Can be repeated for credit

Open by audition to students who demonstrate considerable technical and musical skills and who wish to develop them through intensive private study. Students must take a weekly lesson, attend a regular performance seminar, and participate in a departmental performing group. Full-year commitment required. Information about lesson fees, scholarships, and auditions available in Music Section Office. Meets with graduate subject 21M.512, but assignments differ.

Fall: D. Deveau, M. Thompson
Spring: D. Deveau

21M.490 Emerson Scholar’s Solo Recital
(Subject meets with 21M.525)
Prereq: Permission of instructor
U (Spring)
1-2-3
Can be repeated for credit

Emerson Scholars may receive credit for a solo spring recital that has been prepared with and approved by the private teacher and the Emerson Private Studies Committee. Approval based on evidence of readiness shown in first term master classes. Restricted to Emerson Scholars.

M. Thompson, D. Deveau

Special Topics/Advanced Subjects

21M.500 Senior Seminar in Music
Prereq: 21M.302 and two 21M.2xx subjects
U (Fall)
3-0-9 HASS

Develop analytic and research skills in music. Focus upon a small number of important works, which are studied in depth. Strong emphasis upon student presentations and discussion, and a substantial writing project.

P. Child

21M.505 Music Composition
(Subject meets with 21M.351)
Prereq: 21M.304, 21M.310, or permission of instructor
G (Spring)
3-0-9
Can be repeated for credit

Directed composition of original writing involving voices and/or instruments. Includes a weekly seminar in composition for the presentation and discussion of work in progress. Students are expected to produce at least one substantive work and perform it in public by the end of the term. Contemporary compositions and major works from 20th-century music literature are studied. Students taking the graduate version complete different assignments.

K. Makan

21M.515 Vocal Repertoire and Performance
(Subject meets with 21M.410)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-3
Can be repeated for credit

For the singer and/or pianist interested in collaborative study of solo vocal performance. Historical study of the repertoire includes listening assignments of representative French, German, Italian, and English works as sung by noted vocal artists of the genre. Topics include diction as facilitated by the study of the International Phonetic Alphabet; performance and audition techniques; and study of body awareness and alignment through the Alexander Technique and yoga. Admission by audition. Emerson Vocal Scholars contact department.

P. Wood

21M.525 Emerson Scholars Solo Recital
(Subject meets with 21M.490)
Prereq: None
G (Spring)
1-2-3
Can be repeated for credit

Emerson Scholars may receive credit for a solo spring recital that has been prepared with and approved by the private teacher and the Emerson Private Studies Committee. Approval based on evidence of readiness shown in first term master classes. Restricted to Emerson Scholars.

M. Thompson, D. Deveau

21M.531, 21M.533, 21M.536, 21M.538 Special Topics in Music
Prereq: Any two subjects in Music
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Open to qualified students who wish to pursue special studies or projects with members of the Music Section. Students electing this subject must secure the approval of the chairman of the Music Section. HASS credit for Special Topics subjects awarded only by individual petitions to the Committee on Curricula. Normal maximum is 6 units; to count toward HASS Requirement, 9 units are required. Exceptional 9-unit projects occasionally approved.

Consult Music Section Office
21M.539 Advanced Topics in Music
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Opportunity for advanced study of musical topics not covered by the regular subject listings. Students seeking an individual program of study with a particular faculty member must also obtain the approval of the section head. Consult Music Office for Departmental Form

21M.540 Selected Topics in Music
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit
Opportunity for study of musical topics not covered in the regular curriculum, particularly experimental subjects offered by permanent and visiting faculty.
Staff

21M.542 IAP Music Topics
Prereq: Permission of instructor
U (IAP)
Units arranged
Can be repeated for credit
Opportunity for study of musical topics not covered by the regular subjects listings. Includes experimental subjects offered by permanent and visiting faculty. Students seeking an individual program of study with a particular faculty member must also obtain the approval of the section head. Consult Music Office for Departmental Form

21M.545, 21M.546 Research in Music
Prereq: None
U (Fall, Spring, Summer)
Units arranged
21M.547 Research in Music
Prereq: None
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit with permission of instructor
Directed research on problems occurring in the production, perception, or cognition of music, aided by the techniques and discipline of science and engineering. Individual or group work. Available also to research assistants for non-thesis work.
Consult B. Vercoe

Music and Media

21M.565J Writing for Computer Performance
(Same subject as MAS.642J)
Prereq: MAS.641
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject MAS.642J.
B. Vercoe

21M.566J Audio Processing by People and Machines
(Same subject as MAS.641J)
(Subject meets with MAS.241)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject MAS.641J.
B. Vercoe

21M.570 Computer Music Composition
Prereq: 21M.565J
G (Fall, Spring)
3-0-3 H-LEVEL Grad Credit
Can be repeated for credit
Directed composition of larger forms of original writing using computer-processed sound, to be performed either alone or with voices and/or instruments. Includes a weekly seminar in composition for the examination of major works from 20th-century music literature and for the presentation and discussion of student works in progress. Students expected to produce at least one substantive work to be performed in public by the end of the term. Open to qualified undergraduates.
B. Vercoe

21M.580J Musical Aesthetics and Media Technology
(Same subject as MAS.825J)
Prereq: Permission of instructor
G (Fall)
3-3-3 H-LEVEL Grad Credit
See description under subject MAS.825J.
T. Machover

21M.581J Projects in Media and Music
(Same subject as MAS.826J)
Prereq: MAS.825J
G (Spring)
3-3-6 H-LEVEL Grad Credit
Can be repeated for credit
See description under subject MAS.826J.
T. Machover

THEATER ARTS

The subjects listed below are arranged in three sections: Introductory subjects; Intermediate subjects; and Special Topics/Advanced subjects.
For subjects dealing with the literature of the theater, see 21L.009, 21L.422, 21L.486, 21L.703 in Literature.

Introductory Subjects

21M.600 Introduction to Acting
Prereq: None
U (Fall, Spring)
4-0-5 HASS
Explores the actor’s tools: body, voice, mind, imagination, and the essential self. Through studio exercises, students address issues of honesty and creativity in the theatrical moment, and begin to have a sense of their strengths and limitations as communicating theatrical artists. Provides an opportunity for students to discover their relationship to “the other” in the acting partner, the group, the environment, and the audience.
A. Brody, K. Mancuso

21M.603 Design for the Theater: Projects in Making
Prereq: None
U (Fall)
3-0-6 HASS
Focuses on the process of designing for the theater. Projects center on awakening the imagination in response to an object, and finding the visual way to represent that response. Explores ways designers approach a script or take a piece of music to create something visual, or to arrange and move a series of objects to tell a story. Students work individually and collaboratively to create drawings, paintings, sculptures, models, collages, and live tableaux.
S. L. Brown

21M.604J Playwriting I
(Same subject as 21W.754J)
Prereq: None
U (Fall, Spring)
3-0-9 HASS
Introduces the craft of writing for the theater. Through weekly assignments, in class writing exercises, and work on a sustained piece, students explore scene structure, action, events, voice, and dialogue. Examine produced play-scripts and discuss student work. Emphasis on
process, risk-taking, and finding one’s own voice and vision.
L. Harrington

21M.605 Voice and Speech for the Actor
Prereq: None
U (Fall, Spring)
4-0-5 HASS
Can be repeated for credit
Concentrates upon freeing the natural voice through awareness of physical, vocal and, at times, emotional habits and the willingness and desire to experience change. Teaches progression of Linklater’s approach to voice through in-class vocal exercises. Students use sonnets or haiku to explore the components of language revealed through the voice. Designed for students interested in theater or developing their voice for presentations and professional speaking.
K. Eastley

21M.606 Introduction to Stagecraft
Prereq: None
U (Fall, Spring)
3-3-3 HASS
Introduces the essential technical and engineering knowledge necessary to realize the design of a theatrical production and provides experience with the variety and scope of stagecraft. Students develop a working vocabulary; learn basic shop and handwork skills, including drafting, cutting patterns; and the safe use of all shop machines. Provides a theoretical overview of, and hands-on experience with, the various activities that occur in each shop, including sets, costumes, and lighting. Students complete projects that use all basic skills learned in these three technical and design domains. Students design and build an individual final project of their choosing that employs the stagecraft skills acquired over the term. Enrollment limited to 16.
M. Katz, S. Brown, K. Perlow, L. Held

21M.610 Foundations of Theater Practice
Prereq: None
U (Fall)
3-3-6 HASS-D, Category 3
Introduces the ideas, skills, and aesthetic issues which comprise the creation of the theatrical event. Guest artists and faculty members introduce the work of different disciplines such as directing, stagecraft, design, acting, dramaturgy, and criticism. Readings and in-class exercises help students understand and experience the basic creative impulse in each area.
J. Sonenberg

21M.616 Learning from the Past: Drama, Science, Performance
(Subject meets with 21L.016)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS-D, Category 3, CI-H
Explores the creation (and creativity) of the modern scientific and cultural world through study of western Europe in the 17th century, the age of Descartes and Newton, Shakespeare, Milton and Ford. Compares period thinking to present-day debates about the scientific method, art, religion, and society. This team-taught, interdisciplinary subject draws on a wide range of literary, dramatic, historical, and scientific texts and images, and involves theatrical experimentation as well as reading, writing, researching and conversing.
D. Henderson, J. Sonenberg

21M.617 Science and the Theatrical Imagination
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS-D, Category 3, CI-H
Explores how major western dramatic texts reflect the scientific thinking of various periods in history, up to present time. Discussion focuses on how scientific issues informed the play writers of each period from Aeschylus to Stoppard. Reading includes playscripts and scientific writing. Guests include MIT science and engineering faculty.
A. Brody

21M.621J Theater and Cultural Diversity in the US
(Same subject as SP.595J)
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 3
Explores contemporary American theatrical expression around issues of gender, ethnic, and cultural identities. Analyzes performances, scripts, video documentation, and invention of original documents of theatrical expression, and construction of gender within particular formations of American culture. Class lectures and discussions analyze samples of Native American, Chicano, African-American, and Asian-American theater, considering the historical and political context for the creation of these works. Performance exercises help identify theatrical forms used by these theaters and consider how these techniques contribute to the overall goals of specific theatrical expressions.
T. DeFrantz

21M.630J Black Matters: Introduction to Black Studies
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 4, CI-H
Interdisciplinary survey of people of African descent that draws on the overlapping approaches of history, literature, anthropology, legal studies, media studies, performance, linguistics, and creative writing. Connects the experiences of African-Americans and of other American minorities, focusing on social, political, and cultural histories, and on linguistic patterns. Includes lectures, discussions, workshops, and required field trips that involve minimal cost to students.
T. DeFrantz, S. Alexandre, C. Capozzola

21M.645 Composition for Stage and Performance
Prereq: 21M.600 or permission of instructor
U (Fall)
4-2-3 HASS
Examines the theatrical event from the perspective of composition in a performance workshop. Studio exercises address the process of developing a theatrical work through an internalized understanding of compositional principles in theater. Examines uses of time, space, and action. Complemented by outside readings, videos, short essays, and in-class discussions, subject provides performer, director, choreographer, designer or writer opportunities to engage with large and small group ensembles in creation of theatrical events. Topics include image, movement, shape, repetition, gesture, and spatial relationship.
J. Scheib

21M.670J Traditions in American Concert Dance: Gender and Autobiography
(Same subject as SP.591J)
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 3, CI-H
Explores forms, content, and contexts of world traditions in dance that played a crucial role in shaping American concert dance with attention to issues of gender and autobiography. Explores artistic lives of dance artists Katherine Dunham, Alvin Alley, Isadora Duncan, Martha Graham, and George Balanchine as American dance innovators. Lectures and discussions analyze these artists’ works, taking into consideration historical and political contexts. Viewing assignments and attendance of Boston-area dance performances help students identify visual, musical,
and kinesthetic underpinnings of choreographic structure.
T. DeFrantz

21M.675 Dance Theory and Composition
Prereq: None
U (Fall, Spring)
3-0-6 HASS
Explores aesthetic and technical underpinnings of contemporary dance composition. Basic compositional techniques discussed and practiced with an emphasis on principles such as weight, space, time, effort, and shape. Principles of musicality considered and developed by each student. Working together, students create short compositions to help them understand the range of possibilities available when working with the medium of the human body. Selected viewing and reading exercises augment classroom work. Class attends at least two professional dance events in the Boston area.
Fall: C. Paris
Spring: S. Collins

Intermediate Subjects

21M.703J Media and Methods: Performing
(Same subject as CMS.403J)
Prereq: CMS.100, 21L.011, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-3-6 HASS
See description under subject CMS.403J.
J. Scheib

21M.704 Musical Theater Workshop
Prereq: 21M.600 or permission of instructor
U (Spring)
3-0-6 HASS
Introduces students to the art and technique of musical theater performance. Movement, singing, and acting are explored during the term, with a focus on the use of the body as an expressive tool. Students develop an understanding of how musicals are composed and the nature of the actor’s contribution to this dynamic form. Previous experience in musical theater preferred.
T. DeFrantz

21M.710 The Actor and the Text
Prereq: 21M.600 or permission of instructor
U (Fall, Spring)
4-0-5 HASS
Can be repeated for credit
Gives students who have begun the process of bringing themselves to a dramatic moment the opportunity to apply their skills to scripted material. Studio work in this class further develops the completeness, spontaneity, and honesty of expression of the actor’s body, imagination, and voice; and introduces written material and the problems of synthesizing the self, the moment, and the scripted word. Weekly rehearsals with a scene partner.
A. Brody

21M.710 Script Analysis
Prereq: None
U (Fall)
3-0-9 HASS, CI-H
Focuses on reading a script theatrically with a view to mounting a coherent production. Through careful, intensive reading of a variety of plays from different periods and different aesthetics, a pattern emerges for discerning what options exist for interpreting a script. Students discuss the consequences of those options for production. Enrollment limited.
M. Ouellette

21M.711 Production Seminar
Prereq: None
U (Fall)
3-0-6 HASS
Pursues detailed study of a particular playtext or theme and is related to some planned production activity during the following IAP. Seminar activities may include guest speakers from various disciplines who approach some aspect of the playtext or theme from the perspective of their fields; various theatrical practitioners; and critical and scholarly presentations by seminar members. Participation in the IAP production is required.
J. Scheib

21M.712 African American Performance
Prereq: None
U (Spring)
3-0-6 HASS
Investigates the musicality, movement styles, and structures of oratory central to African American life. Explores storytelling, tall tales and snapping, the blues aesthetic and soul, minstrelsy and social dance through the prism of plays written by African American writers. Examines the participatory, communal essence of black performance and how that performance functions as cultural inspiration, as political weaponry, as art, as religion, and as an entertaining social safety valve. Required readings, written essays, and midterm writing project in addition to creation of short performance pieces.
T. DeFrantz

21M.713 Selected Studies in Theater
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Can be repeated for credit
Discussion-oriented class that focuses on the theater of a particular culture or a specific theatrical form. Students read several plays over the course of the term that may be supplemented by history, theory, contemporary source documents, etc. At the discretion of the instructor, additional requirements may include attending theatrical productions in Boston and written assignments, such as a reader journal, response papers, or an analytical paper. Possible topics include plays about science, Latino theater, feminist theater, and gay/lesbian theater.
Staff

21M.714 Selected Topics in Theater Arts
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit
Provides opportunity for study of topics in theater arts not covered by the regular subject listings, particularly experimental subjects offered by permanent and visiting faculty.
Consult Theater Arts Office

21M.715 Topics in Technical Theater Design Exploration
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit
Provides opportunity for study of theater design or technical topics not covered by the regular subject listings. Experimental subjects, advanced design exploration, advanced craft techniques such as structural design for the stage, or specialty costume designs like chainmail or hat construction.
Theater Arts Faculty
21M.732 Costume Design for the Theater
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-3-6 HASS

Provides an intermediate workshop designed for students who have a basic understanding of the principles of theatrical design and who want a more intensive study of costume design and the psychology of clothing. Students develop designs that emerge through a process of character analysis, based on the script and directorial concept. Period research, design, and rendering skills are fostered through practical exercises. Instruction in basic costume construction, including drafting and draping, provides tools for students to produce final projects.
L. Cocuzzo-Held

21M.733 Design for the Theater: Scenery
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-3-6 HASS

Examines theory of scenic design as currently practiced and alternate traditions in other cultures and eras. Four play scripts and one opera or dance theater piece are designed after being analyzed in depth, exploring their internal workings and relationship to the social, political, artistic, and cultural milieu of their era of creation, and to the current audience. Encourages students to work in a variety of two- and three-dimensional media in developing their ideas.
Staff

21M.734 Lighting Design for the Theater
Prereq: Permission of instructor
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-3-3 HASS

Explores artistry of lighting design. Students gain overall technical working knowledge of tools and apply it to final design. Stresses artistic, conceptual, and collaborative side of the craft utilizing a “hands on” format. Students take advantage of greater Boston venues with backstage tours of various theaters to see how architecture affects lighting design choices. Small projects assigned during term. Final project involves execution of fully realized production, frequently for the Dance Theater Ensemble’s winter concert.
K. Perlow

21M.735 Technical Design: Scenery, Mechanisms, and Special Effects
Prereq: 21M.606 or permission of instructor
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-3-6 HASS

Looks at special structural and artistic challenges of theatrical scenery, effects, and construction needs. Explores the technical design process and emphasizes safety, budgeting, and problem solving. Work includes actual production assignments and paper design projects. Final project required to explore each student’s specific interests.
M. Katz

21M.775 Hip-Hop
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-3-6 HASS

Explores the political and aesthetic foundations of hip-hop. Students trace the musical, corporeal, visual, spoken word, and literary manifestations of hip hop over its 30 year presence in the American cultural imagery. Students also investigate specific black cultural practices that have given rise to its various idioms. Students create material culture related to several thematic sections of the course. Scheduled work in performance studio helps students understand how hip-hop is created and assessed.
T. DeFrantz

21M.785J Playwrights’ Workshop
(Same subject as 21W.769J)
Prereq: 21M.604, 21W.754 or permission of instructor
U (Spring)
3-2-7 HASS
Can be repeated for credit

Continues work in the development of play scripts for the theater. Writers work on sustained pieces in weekly workshop meetings, individual consultation with the instructor, and in collaboration with student actors, directors, and designers. Fully developed scripts eligible for inclusion in the Playwrights’ Workshop production.
A. Brody

21M.789 Playwrights’ Workshop
(Subject meets with 21M.785J, 21W.769J)
Prereq: 21M.604, 21W.754 or permission of instructor
G (Spring)
3-2-7
Can be repeated for credit

Meets with 21M.785J and 21W.754J but assignments differ.
A. Brody

21M.790 The Director’s Craft
(Subject meets with 21M.791)
Prereq: 21M.600 and 21M.710 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
4-0-5 HASS

Explores several models of directing, each with its unique structures, philosophy, terminology, and techniques. Exploration is intended to lead to the development of an individual voice for each student and clarity in his/her directorial point of view. Class sessions concentrate on how a point of view is arrived at through analysis of material and the way the results are rendered with the basic tools of theater. All points of view are honored as long as they can be actively supported by the work.
J. Sonenberg

21M.791 The Director’s Craft
(Subject meets with 21M.790)
Prereq: 21M.600 and 21M.710 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
4-0-5

See description under subject 21M.790.
J. Sonenberg

Special Advanced Topics and Practica

21M.805 Theater Practicum
Prereq: At least one studio subject or permission of instructor
U (Fall, IAP, Spring; second half of term)
Units arranged
Can be repeated for credit

Provides directed practice in acting or directing on a sustained theater piece, either one-act or full length, from pre-rehearsal preparation to workshop production. Consult Theater Arts Office.
Staff
21M.815 Technical Theater Practicum
Prereq: One Theater Arts subject or permission of instructor
U (Fall, IAP, Spring; second half of term)
Units arranged
Can be repeated for credit
Provides directed practice in theater design or technical production while working on a Theater Arts production.
Consult Rinaldi Staff

21M.820 Technical Theater Special Topics
Prereq: At least one Theater Arts subject or permission of instructor
U (Fall, IAP, Spring; second half of term)
Units arranged
Can be repeated for credit
Provides opportunity to study theater design and technical production subjects including technical theater practica or experimental subjects offered by the permanent or visiting faculty.
Staff

21M.830 Acting: Techniques and Style
(Subject meets with 21M.835)
Prereq: 21M.600, 21M.705
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
4-0-8 HASS
Can be repeated for credit
Refines the student actor’s use of the language of the stage with work on text and physical presentation. Explores issues of style, including the understanding and honoring, in performance, of the specific requirements of texts from several different historical periods of the Western theatrical tradition. Periods may differ from term to term.
M. Ouellette

21M.835 Acting: Techniques and Style
(Subject meets with 21M.830)
Prereq: 21M.600, 21M.705
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
4-0-8
Can be repeated for credit
Meets with 21M.830 but assignments differ. Graduate students are expected to complete additional assignments.
M. Ouellette

21M.840 Performance Media
(Subject meets with 21M.841)
Prereq: None
U (Spring)
4-2-6 HASS
Integrates media and communication technologies in performing arts. Studio exercises provide a forum for experimentation. Contemporary and historical techniques for media integration examined through readings, viewing videos and short written essays. Technologies examined include digital imaging, composite and live feed digital video, and web-based performance. Engages the designer, director, choreographer, performer, visual artist or programmer in the practice of integrating media into live art events. Equipment, where necessary, is provided.
J. Scheib

21M.841 Performance Media
(Subject meets with 21M.840)
Prereq: None
G (Spring)
4-2-6
Meets with 21M.840 but assignments differ. Graduate students are expected to complete additional assignments. See description under 21M.840.
J. Scheib

21M.846 Topics in Performance Studies
(Subject meets with 21M.847)
Prereq: None
U (Spring)
3-2-7 HASS
Can be repeated for credit
Multidisciplinary lecture/workshop engages students in a variety of approaches to the study and practice of performance as an area of aesthetic and social interaction. Special attention paid to the use of diverse media in performance. Interdisciplinary approaches to study encourage students to seek out material histories of performance and practice. New topics are discussed each year.
T. DeFrantz

21M.847 Topics in Performance Studies
(Subject meets with 21M.846)
Prereq: None
G (Spring)
3-2-7
Can be repeated for credit
See description under 21M.846. Assignments differ.
T. DeFrantz

21M.851 Special Topics in Drama
Prereq: Permission of instructor
U (Fall, IAP, Spring; second half of term)
Units arranged
Can be repeated for credit

21M.852 Special Topics in Drama
Prereq: Permission of instructor
U (Fall, IAP, Spring; second half of term)
Units arranged [P/D/F]
Can be repeated for credit
Allows students to pursue topics of interest as independent study. HASS GIR credit for Special Topics subjects awarded only by individual petitions to the Committee on Curricula. Normal maximum is 6 units; to count toward HASS Requirement, 9 units are required. Exceptional 9-unit projects occasionally approved.
Consult Theater Arts Office

21M.863 Advanced Topics in Theater Arts
Prereq: Any two subjects in Theater Arts or permission of instructor
U (Fall, IAP, Spring; second half of term)
Units arranged
Can be repeated for credit
Gives opportunity for advanced study in theater arts not covered by the regular subject listings. Includes experimental subjects offered by permanent and visiting faculty. Students seeking an individual program of study with a particular faculty member must also obtain the approval of the Director of Theater Arts.
Consult Theater Arts Office

21M.864 Theater Studies
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Provides opportunity for the study of theatrical topics not covered in the regular curriculum, particularly experimental subjects offered by faculty or visiting faculty.
Consult Theater Arts Office

21M.865 Research in Theater
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit with permission of instructor
Offers directed research of advanced theatrical subjects occurring in either the performance or theoretical spheres.
Consult Theater Arts Office
21M.873 IAP Theater Arts Topics
Prereq: Permission of instructor
U (IAP)
Units arranged
Can be repeated for credit
Provides opportunity for the study of theater arts topics not covered by regular subject listings, including experimental subjects offered by permanent and visiting faculty. Students seeking an individual program of study with a faculty member must also obtain the approval of the director of Theater Arts. Consult Theater Arts office for departmental form.

Staff

21M.880 Dance Production
(Subject meets with 21M.881)
Prereq: None
U (Fall, Spring; second half of term)
0-4-2
Can be repeated for credit

21M.881 Dance Production
(Subject meets with 21M.880)
Prereq: None
G (Fall, Spring; second half of term)
0-4-2
Can be repeated for credit
Prepares students in rehearsals for concert performance of original dance works in various idioms, focusing on expressive elegance and the creative process. Open to students by audition. T. DeFrantz

21M.ThT Music Pre-Thesis Tutorial
Prereq: Music major status
U (Fall, Spring)
1-0-5
Can be repeated for credit
Definition of and early-stage work on thesis project leading to 21M.ThU Undergraduate Thesis in Music. Taken during the first term of the student’s two-term commitment to the thesis project. Student works closely with an individual faculty tutor. Consult L. Lindgren

21M.ThU Undergraduate Thesis in Music
Prereq: 21M.ThT
U (Fall, Spring)
Units arranged
Can be repeated for credit
Completion of work on senior major thesis under supervision of a faculty tutor. Includes oral presentation of thesis progress early in the term, assembling and revising final text, and meeting at the close with a committee of faculty evaluators to discuss successes and limitations of the project. Consult L. Lindgren

21M.UR Research in Music
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

21M.URG Research in Music
U (Fall, Spring)
Units arranged
Can be repeated for credit
Individual participation in an ongoing music research project. For students in the Undergraduate Research Opportunities Program. Consult L. Lindgren

Note that thesis is not a requirement of the music program.

Theater Arts students are required to produce a thesis. Since their programs are major departures in the School of Humanities, Arts, and Social Sciences they should register for 21.ThT and 21.ThU. They should also register for 21.UR or 21.URG when doing UROP projects.

Note that thesis is not a requirement of the music program.
# Bachelor of Science in Music/Course 21M

### General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [three subjects can be from the Departmental Program]</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**: 17

### Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

### PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

#### Required Subjects

- 21M.220 Early Music, 12, HASS, CI-M; 21M.011*
- 21M.301 Harmony and Counterpoint I, 12, HASS-D; 21M.051*
- 21M.302 Harmony and Counterpoint II, 12, HASS; 21M.301
- 21M.303 Writing in Tonal Forms I, 12, HASS; 21M.302
  or 21M.350 Musical Analysis, 12, HASS; 21M.302*
- Two terms of Performance subjects, 21M.401–21M.499 (6 units each)
- 21M.500 Senior Seminar in Music, 12, HASS, CI-M; 21M.302, two 21M.xxx subjects

#### Restricted Electives

Four electives, consisting of one subject from each category below (12 units each):
- Theory/composition (21M.300–21M.399)
- Western music (21M.226–21M.289)
- World music (21M.291–21M.299)
- Choice of theory/composition, history/literature, or two terms of performance to be selected in consultation with the major advisor

Full majors may, with faculty approval, substitute three full years of 21M.480 Advanced Musical Performance and a senior recital for the two required terms of performance subjects and two of the four electives.

### Departmental Program Units That Also Satisfy the GIRs

(36)

### Unrestricted Electives

96

**Total Units Beyond the GIRs Required for SB Degree**: 180

*No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.*

### Notes

* Alternate prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
The Program in Writing and Humanistic Studies has three undergraduate subject options:

1) Creative Writing;
2) Science Writing; and
3) Digital Media.

Introductory subjects are designed for beginning college writers; advanced subjects are designed to develop greater competence in one or more special forms of writing.

INTRODUCTORY

21W.730 Writing on Contemporary Issues
Prereq: None
U (Fall, Spring)
3-0-9 HASS, CI-HW

Focuses on forms of exposition, including narration, critique, argument, and persuasion, to develop students' ability to write clear and effective prose. Readings and assignments vary by section; each section focuses on a specific theme such as contemporary social problems, the culture of food, and forms of popular culture. Students write frequently, give and receive feedback on work in progress, improve their work by revising, read the work of accomplished writers, and participate actively in class discussions and workshops. Requires short oral presentations. Emphasizes writing with an awareness of audience and purpose. See departmental website for complete descriptions of sections. Limited to 18. Staff

21W.731 Writing and Experience
Prereq: None
U (Fall, Spring)
3-0-9 HASS, CI-HW

Focuses on the ways writers transform experience into finished and polished writing in the forms of essay, memoir, and autobiography. Students write frequently, give and receive feedback on work in progress, improve their writing by revising, read the work of accomplished writers, and participate actively in class discussions and workshops. Requires short oral presentations. Emphasizes writing with an awareness of audience and purpose. Readings and specific writing assignments vary by section. See departmental website for complete descriptions of sections. Limited to 18. Staff

21W.732 Science Writing and New Media
Prereq: None
U (Fall, Spring)
3-0-9 HASS, CI-HW

Focuses on writing about science and new media and emphasizes developing students' ability to write clear and effective prose for a range of media. Readings and assignments vary by section; each section focuses on a specific theme such as technical and scientific writing, writing about science for a public audience, the environment, digital media, and others. Students write frequently, give and receive feedback on work in progress, improve their writing by revising, read the work of accomplished writers, and participate actively in class discussions and workshops. Requires short oral presentations. See departmental website for complete descriptions of sections. Enrollment limited. Staff

21W.734J Writing About Literature
(Same subject as 21L.000J)
Prereq: None
U (Fall, Spring)
3-0-9 HASS, CI-HW

See description under subject 21L.000J.
Fall: W. Kelley
Spring: I. Lipkowitz

21W.735 Writing and Reading the Essay
Prereq: 21W.730, or excellent writing sample and permission of instructor
U (Fall)
3-0-9 HASS-D, Category 1, CI-H

Exploration of formal and informal modes of writing nonfiction prose. Extensive practice in composition, revision, and editing. Reading in the literature of the essay from the Renaissance to the present, with an emphasis on modern writers. Classes alternate between discussion of published readings and workshops on student work. Individual conferences. R. Faery

CREATIVE WRITING

Introductory

See subjects 21W.730, 21W.731, and 21W.734J.

21W.754J Playwriting I
(Same subject as 21M.604J)
Prereq: None
U (Fall, Spring)
3-0-9 HASS

See description under subject 21M.604J.
L. Harrington

21W.755 Writing and Reading Short Stories
Prereq: None
U (Fall, Spring)
3-0-9 HASS

Introduction to the short story. Students write stories and short descriptive sketches. Readings from European and American stories from the 18th, 19th, and 20th centuries. Class discussion of students' writing and of the assigned stories in their historical and social contexts.
Fall: S. Lewitt, H. Lee
Spring: S. Lewitt

21W.756 Writing and Reading Poems
Prereq: None
U (Fall, Spring)
3-0-9 HASS

Examination of the formal structural and textual variety in poetry. Extensive practice in the making of poems and the analysis of both students' manuscripts and texts from 16th- through 20th-century literature. Attempts to make relevant the traditional elements of poetry and their contemporary alternatives. Weekly writing assignments, including some exercises in prosody. W. Corbett

Advanced

21W.735 Writing and Reading the Essay
Prereq: 21W.730, or excellent writing sample and permission of instructor
U (Fall)
3-0-9 HASS-D, Category 1, CI-H

Exploration of formal and informal modes of writing nonfiction prose. Extensive practice in composition, revision, and editing. Reading in the literature of the essay from the Renaissance to the present, with an emphasis on modern writers. Classes alternate between discussion of published readings and workshops on student work. Individual conferences. R. Faery
21W.736 News Writing
Prereq: None
U (Fall)
3-0-9 HASS
An introduction to the basics of print journalism, including an overview of journalistic ethics and life in the newsroom. Students learn basic reporting techniques, interviewing, and news writing, with an emphasis on accuracy, clarity, and brevity. Most writing done in class whereby students learn to write under time pressure, as well as in a distracting environment. Techniques of investigative reporting—including interviewing and research into public and private sources—are assigned on a weekly basis for outside classroom work.
B. D. Colen

21W.739J Darwin and Design
(Same subject as 21L.448J)
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 2, CI-H
See description under subject 21L.448J.
A. Kibel, J. Paradis

21W.740 Writing Autobiography and Biography
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Writing an autobiography is a vehicle for improving one's style while studying the nuances of the language. Literary works are read with an emphasis on different forms of autobiography. Students examine various stages of life, significant transitions, personal struggles, and memories translated into narrative prose, and discuss: what it means for autobiographer and biographer to develop a personal voice; and the problems of reality and fiction in autobiography and biography.
K. Manning

21W.741J Black Matters: Introduction to Black Studies
(Same subject as 21H.106J, 21L.008J, 21M.630J)
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 4, CI-H
See description under subject 21M.630J.
T. DeFrantz, S. Alexandre, C. Capozzola

21W.742J Writing about Race
(Same subject as SP.575J)
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 2, CI-H
The issue of race and racial identity have preoccupied many writers throughout the history of the US. Students read Jessica Abel, Diana Abu-Jaber, Lynda Barry, Felicia Luna Lemus, James McBride, Sigrid Nunez, Ruth Ozeki, Danzy Senna, Gloria Anzaldúa, Judith Ortiz Cofer, Camít Delman, Stefanie Dunning, Cherrie Moraga, Hiram Perez and others, and consider the story of race in its peculiarly American dimensions. The reading, along with the writing of members of the class, is the focus of class discussions. Oral presentations on subjects of individual interest are also part of the class activities. Students explore race and ethnicity in personal essays, pieces of cultural criticism or analysis, or (with permission of instructor) fiction. All written work is read and responded to in class workshops and subsequently revised. Enrollment limited.
K. Ragusa

21W.745 Advanced Essay Workshop
(Subject meets with SP.576)
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS, CI-H
Can be repeated for credit
For students with experience in writing essays and nonfiction prose. Focuses on negotiating and representing identities grounded in gender, race, class, nationality, and sexuality in prose that is expository, exploratory, investigative, persuasive, lyrical, or incantatory. Authors include James Baldwin, Minnie Bruce Pratt, Audre Lorde, Richard Rodriguez, Alice Walker, John Edgar Wideman, Diana Hume George, bell hooks, Margaret Atwood, Patricia J. Williams, and others. Designed to help students build upon their strengths as writers and to expand their repertoire of styles and approaches in essay writing.
R. Faery

21W.746 Humanistic Perspectives on Medicine: From Ancient Greece to Modern America
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 5, CI-H
For students with experience in nonfiction prose and interest in the non-science side of medicine. Advanced study of the art of essay (form, style, techniques of persuasion) and practice of that form. Students required to write substantial essays and revise their work. Students read and discuss the writings of distinguished physicians from antiquity to the late 20th century.
K. Manning

21W.747 Rhetoric
Prereq: None
U (Fall, Spring)
3-0-9 HASS-D, Category 2, CI-H
For students with a special interest in learning how to make forceful arguments in written form. Studies the forms and structures of argumentation, including organization of ideas, awareness of audience, methods of persuasion, evidence, factual vs. emotional argument, figures of speech, and historical forms and uses of arguments.
Fall: S. Strang, L. Perelman, M. Poe
Spring: S. Strang, L. Perelman

21W.749 Documentary Photography and Photojournalism: Still Images of a World in Motion
(Subject meets with CMS.935)
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS
Designed to increase students’ understanding of, appreciation for, and ability to do documentary photography and photojournalism. Each three-hour class is divided between a discussion of issues and readings, and a group critique of students’ projects. Students must have their own photographic equipment and be responsible for processing and printing: either by student or commercial lab. Students must show basic proficiency with their equipment. Readings include Susan Sontag, Robert Coles, Ken Light, Eugene Richards, and others. Previous photographic experience required. Enrollment limited to 15.
B. D. Colen

21W.757 Fiction Workshop
Prereq: 21W.755
U (Fall, Spring)
3-0-9 HASS
Can be repeated for credit
For students interested in developing their understanding of the craft of fiction. Weekly workshop discussions of students’ work focus on analysis of structure, style, and characterization. Emphasis on editing and revision. Reading and discussion of 19th- and 20th-century authors, such as Babel, Carver, Chekhov, Faulkner, Kafka, Orwell, Márquez, and Woolf.
H. Lee
21W.758 Genre Fiction Workshop
Prereq: A subject in writing short fiction or comparable writing experience
U (Fall) 3-0-9 HASS

Students read stories from various genres about catastrophes, natural and human-made, and write stories in specific genres, although not necessarily about the reading topic. Readings include The Last Days of Pompeii (historical fiction), The Tin Roof Blowdown (suspense), Gogol’s The Overcoat (fantasy), and the science fiction novels No Blade of Grass and A Canticle for Leibowitz. Students consider genre protocols and how to write within the restrictions and freedoms associated with each genre. Students write a short reaction to each novel, and one short story within a genre or between genres for round-table workshops. Enrollment limited to 15.
J. Haldeman

21W.759 Writing Science Fiction
Prereq: None
U (Fall) 3-0-9 HASS

Students write and read science fiction and analyze and discuss stories written for the class. For the first eight weeks, readings in contemporary science fiction accompany lectures and formal writing assignments intended to illuminate various aspects of writing craft as well as the particular problems of writing science fiction. The rest of the term is given to roundtable workshops on students’ stories.
J. Haldeman

21W.762 Poetry Workshop
Prereq: None
U (Fall, Spring) 3-0-9 HASS
Can be repeated for credit

For students with some previous experience in poetry writing. Frequent assignments stress use of language, diction, word choice, line breaks, imagery, mood, and tone. Considers the functions of memory, imagination, dreams, poetic impulses. Throughout the term, students examine the work of published poets. Revision stressed.
Fall: E. Funkhouser
Spring: E. Barrett

21W.763| Transmedia Storytelling: Modern Science Fiction
(Same subject as CMS.309J)
(Subject meets with CMS.809)
Prereq: None
U (Fall) 3-0-9 HASS

Students investigate the genre of science fiction across different media that include the short story, the screenplay, moving image, and games. Students write critical essays and their own works of science fiction, and submit critical analyses of each other’s efforts in a roundtable workshop environment.
B. Coleman

21W.766| Contemporary US Women of Color: Writing and Reading Short Stories
(Same subject as SP.574J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring) 3-0-9 HASS

Students read short stories by Native American, Latina, African-American, and Asian-American women writers and write their own stories and descriptive sketches. Writing assignments and discussions focus on these themes: reclaiming, reconstructing, and preserving culture; cultural heritage as a source of power and resistance; storytelling as a means of celebration and survival; shifting, contending, and multiple identities; the costs and advantages of breaking silence; and tensions between assimilation and maintaining cultural practices.
H. Lee

21W.769| Playwrights’ Workshop
(Same subject as 21M.785)
(Subject meets with 21M.789)
Prereq: 21M.604, 21W.754 or permission of instructor
U (Spring) 3-2-7 HASS
Can be repeated for credit

See description under subject 21M.785.
A. Brody

21W.770 Advanced Fiction Workshop
Prereq: Permission of instructor
U (Fall, Spring) 3-0-9 HASS
Can be repeated for credit

For students with some experience in writing fiction. Write longer works of fiction and short stories which are related or interconnected. Read short story collections by individual writers, such as Sandra Cisneros, Raymond Carver, Edward P. Jones, and Tillie Olsen, and discuss them critically and analytically, with attention to the ways in which the writers’ choices about component parts contribute to meaning. In-class exercises and weekly workshops of student work focus on sources of story material, characterization, structure, narrative voice, point of view and concrete detail. Concentration on revision.
Fall: J. Diaz
Spring: H. Lee

21W.771 Advanced Poetry Workshop
Prereq: Prior manuscript submission required
U (Spring) 3-0-9 HASS
Can be repeated for credit

For students experienced in writing poems. Regular reading of published contemporary poets and weekly submission of manuscripts for class review and criticism. Students expected to do a substantial amount of rewriting and revision. Classwork supplemented with individual conferences.
E. Funkhouser

21W.772 Digital Poetry
Prereq: None
U (Spring) 3-0-9 HASS

Digital forms of poetry, including hypertext poems, Flash-animated poems, poems within short digital videos and interactive forms of poetry and games. Readings in early hypertext theory and creative writing. Experiment with creating poetry for wireless access on hand held devices. Test the assumptions of these early theorists through practice of creating digital poetry.
E. Barrett

21W.773 Writing Longer Fiction
Prereq: A fiction workshop or permission of instructor
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 HASS

Designed for students who have some experience in writing fiction and want to try longer forms like the novella and novel. Students interested in writing a novel are expected to produce at least two chapters and an outline of the complete work. Readings include several novels from Fitzgerald to the present, and novellas from Gogol’s The Overcoat to current examples.
Students discuss one another’s writing in a roundtable workshop, with a strong emphasis on revision.

J. Haldeman

21W.774 Invention and Ingenuity: Writing about Engineers and the Worlds They Make
Prereq: None
U (Fall)
3-0-9 HASS, CI-H

Introduction to science writing for general audiences, with a particular emphasis on engineers and their work. Through structured writing assignments devoted to engineering as practiced today or in the past, students learn to tell nonfiction stories, explore the intellectual and creative puzzles engineers face, comment on engineering’s social and cultural impact, and illuminate the human drama in engineering work. Students also read and critically discuss compelling examples of such writing in newspapers, magazines, and popular books. Enrollment limited to 16.

K. Boiko

21W.775 Writing about Nature and Environmental Issues
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 1, CI-H

Focuses on traditional nature writing and the environmentalist essay. Students keep a web log as a journal. Writings are drawn from the tradition of nature writing and from contemporary forms of the environmentalist essay. Authors include Henry Thoreau, Loren Eiseley, Annie Dillard, Chet Raymo, Sue Hubbel, Rachel Carson, Bill McKibben, and Terry Tempest Williams.

R. Kanigel

21W.778 Science Journalism
Prereq: None
U (Fall)
3-0-9 HASS, CI-H

An introduction to print daily journalism and news writing, focusing on science news writing in general, and medical writing in particular. Emphasis is on writing clearly and accurately under deadline pressure. Class discussions involve the realities of modern journalism, how newsrooms function, and the science news coverage in daily publications. Discussions of, and practice in, interviewing and various modes of reporting. In class, students write numerous science news stories on deadline. There are additional longer writing assignments outside of class. Enrollment limited.

T. Levenson

21W.781J Communicating About Technology: Colossal Failures in Engineering
(Same subject as 1.588J, 3.070J, 22.002J, ESD.032J)
Prereq: None
U (Spring)
3-0-9 HASS, CI-H

Explores communicating about technological subjects in the context of colossal engineering failures including Three Mile Island, Bhopal, the Columbia Shuttle, 9/11, and Katrina. Examines the basic engineering principles and the social context of several such failures in case studies from various engineering disciplines. Students see how problematic communications, sometimes subtly unrecognizable at the time, significantly contributed to the final failures. Students collaborate to produce a final written and oral research report that anticipates a potential failure and makes recommendations for avoiding it. Multiple sections, each limited to 18 students.

T. Eagar, W. Haas, A. Kadak, P. Lagacé, O. Buyukozturk

See subjects 21W.792, 21W.820J.

SCIENC E WRITING

Introductory

See subject 21W.732.

Advanced

21W.777 The Science Essay
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Drawing in part from their own interests and ideas, students write about science within various cultural contexts. Students employ a broad repertoire of literary tools, such as narrative, scene-setting, and attention to larger issues of structure. Students study the work of science writers such as Alan Lightman, Oliver Sacks and Malcolm Gladwell to help them create essays of substance and grace that have science and technology as their subjects. Not a technical writing class.

K. Boiko

DIGITAL MEDIA

Advanced

21W.764J The Word Made Digital
(Same subject as CMS.609J)
(Subject meets with CMS.846)
Prereq: None
U (Fall)
3-0-9 HASS

Video games, digital art and literature, online texts, and source code are analyzed in the contexts of history, culture, and computing platforms. Approaches from poetics and computer science are used to understand the non-narrative digital uses of text. Students undertake critical writing and creative computer projects to encounter digital writing through practice. This involves reading and modifying computer programs; therefore previous programming experience, although not required, will be helpful. The graduate section includes additional assignments. Enrollment limited to 18.

N. Montfort

21W.765J Interactive and Non-Linear Narrative: Theory and Practice
(Same subject as 21L.489J)
(Subject meets with CMS.845)
Prereq: None
U (Fall)
3-0-9 HASS

Provides a workshop environment for understanding interactive narrative (print and digital) through critical writing, narrative theory, and creative practice. Covers important multisequential books, hypertexts, and interactive fictions. Students write critically, and give presentations, about specific works; write a short multisequential fiction; and develop a digital narrative system, which involves significant writing and either programming or the structuring of text. Programming ability helpful.

N. Montfort

21W.784 Becoming Digital: Writing about Media Change
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 4, CI-H

Compares pre-digital to digital media to explore the unique problems that arise in this transition in relation to documenting conflicts from the perspectives of soldiers, journalists, and civilians. Class selects periods, conflicts and readings. Readings include subject-specific texts and media, augmented by technical and theoretical articles relevant to the course themes. Frequent
writing and revision, an oral presentation, and intensive class participation are required. Limited to 18.

B. Miller

21W.785 Communicating with Web-Based Media
Prereq: None
U (Fall, Spring)
3-0-9 HASS, CI-H

Analysis, design, implementation, and testing of various forms of digital communication through group collaboration. Students are encouraged to think about the Web and other new digital interactive media not just in terms of technology but also broader issues such as language (verbal and visual), design, information architecture, communication and community. Students work in small groups on a term-long project of their choice. Various written and oral presentations document project development.

Fall: V. Bald
Spring: E. Barrett

21W.786J The Social Documentary: Analysis and Production
(Same subject as CMS.336J)
(Subject meets with CMS.836)
Prereq: None
U (Fall)
3-0-9 HASS

An introduction to the history of the social documentary from the 1960s through the 1980s. Explores how social upheaval and the shift to smaller, more portable film cameras, and ultimately hand-held video, converged to bring about an upsurge of socially engaged documentary film production. Students screen and analyze a series of key films from the period and work in groups to produce their own short documentary using digital video and computer-based editing. Enrollment limited to 18.

V. Bald

21W.787 Film, Music, and Social Change: Intersections of Media and Society
(Subject meets with CMS.837)
Prereq: None
U (Spring)
3-0-9 HASS

Examines films from the 1950s onward that document music subcultures and moments of social upheaval. Combines screening films about free jazz, glam rock, punk, reggae, hip-hop, and other genres with an examination of critical/scholarly writings to illuminate the connections between film, popular music, and processes of social change. Students critique each film in terms of the social, political, and cultural world it documents, and the historical context and effects of the film’s reception. Students taking graduate version complete additional assignments. Enrollment limited to 18.

V. Bald

21W.789 Communicating with Mobile Technology
Prereq: 1.00, 6.00S, or permission of instructor
U (Spring)
3-0-9 HASS, CI-H

Students work in small collaborative design teams to propose, build, and document a semester-long project focused on mobile applications for cell phones. Additional assignments include creating several small mobile applications such as context-aware mobile media capture and games. Students document their work through a series of written and oral proposals, progress reports, and final reports. Covers the basics of J2ME and explores mobile imaging and media creation, GPS location, user-centered design, usability testing, and prototyping. Java experience recommended.

E. Barrett

Additional Subjects

21W.792 Science Writing Internship
Prereq: None
U (Spring)
0-12-0 HASS

Can be repeated for credit

Part-time internships in Boston-area media and industries are arranged for students wishing to develop professional writing and publishing skills. Students planning to take this subject must contact the instructor by November of the previous term.

Staff

21W.794 Graduate Technical Writing Workshop
Prereq: None
G (Fall, IAP, Spring)
Units arranged

Draft a thesis proposal, thesis chapter, journal article, progress report, or specification, and review basics of engineering writing. Sessions cover the processes of organizing and drafting professional papers, improving writing style, and revising documents. Students determine own projects; each project increment receives instructor’s editorial suggestions.

W. Haas

21W.797 Communication Workshop for CME
Prereq: Acceptance in the CME program
U (Fall)
1-0-1 [P/D/F]

Communication intensive subject for MIT undergraduates participating in the Cambridge-MIT Exchange program. Intensive week-long workshop focuses on written communication, including discipline-specific material and library research, and emphasizes argumentation skills.

M. Poe

21W.798, 21W.799 Special Topics in Writing
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit

Primarily for students pursuing advanced writing projects with the assistance of a member of the Writing Program. Students electing this subject must secure the approval of the director of the Writing Program and its Committee on Curriculum. HASS credit for Special Topics subjects awarded only by individual petitions to the Committee on Curricula. Normal maximum is 6 units; to count toward HASS Requirement, 9 units are required. Exceptional 9-unit projects occasionally approved. 21W.798 is P/D/F.

J. Paradis

21W.ThT Writing and Humanistic Studies
Pre-Thesis Tutorial
Prereq: None
U (Fall, Spring)
1-0-5

Definition of and early stage work on a thesis project leading to 21W.ThU. Taken during the first term of a student’s two-term commitment to the thesis project. Student works closely with an individual faculty tutor. Required of all students pursuing a full major in Course 21W. Joint majors register for 21.ThT.

Staff

21W.ThU Writing and Humanistic Studies Thesis
Prereq: 21W.ThT
U (Fall, Spring)
Units arranged
Can be repeated for credit

Completion of work on the senior major thesis under the supervision of a faculty tutor. Includes oral presentation of the thesis progress early in the term, assembling and revising the final text, and a final meeting with a committee of faculty evaluators to discuss the successes and limitations of the project. Required of students
pursuing a full major in Course 21W. Joint majors register for 21.ThU.

Staff

21W.UR Research in Writing and Humanistic Studies
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

21W.URG Research in Writing and Humanistic Studies
U (Fall, Spring)
Units arranged
Can be repeated for credit

Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.

J. Paradis

Graduate Subjects

21W.820J Writing: Science, Technology, and Society
(Same subject as STS.477J)
Prereq: 21H.991J
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject STS.477J.

K. Manning

21W.825 Advanced Science Writing Seminar I
Prereq: Permission of instructor
G (Fall)
6-0-18 H-LEVEL Grad Credit

First term of year-long graduate sequence in science writing offers students intensive workshops and critiques of their own writing, and that of published books, articles, and essays; discussions of ethical and professional issues; study of science and scientists in historical and social context; analysis of recent events in science and technology. Emphasis throughout on developing skills and habits of mind that enable the science writer to tackle scientifically formidable material and write about it for ordinary readers. Topics include the tools of research, conceived in its broadest sense- including interviewing, websites, archives, scientific journal articles; science journalism, including culture of the newsroom and magazine-style journalism; science essays. Considerable attention to science writing’s audiences, markets, and publics and the special requirements of each.

R. Kanigel, M. Bartusiak, T. Levenson

21W.826 Advanced Science Writing Seminar II
Prereq: Permission of instructor
G (Spring)
6-0-18 H-LEVEL Grad Credit

Continuation of topics introduced in 21W.825, including research, science journalism, and essays; social and historical context of science and technology; workshops and critiques of student writing. Special emphasis on literary and imaginative science writing that employs traditionally fictional devices in nonfiction, including scene-setting and storytelling; exploration of the boundaries between nonfiction and fiction; relationships between word and image. Extension of science writing principles to non-print domains, such as websites, radio, television, museum exhibits, and multimedia.

R. Rymer, T. Levenson, M. Bartusiak

21W.892 Science Writing Internship
Prereq: Permission of instructor
G (Summer)
0-12-0 [P/D/F] H-LEVEL Grad Credit

Field placements tailored to the individual backgrounds of the students enrolled, involving varying degrees of faculty participation and supervision.

R. Kanigel

21W.898 Special Graduate Elective in Science Writing
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit

Elective choices and sequences arranged by staff to complement the enrolled students’ program of research and study.

R. Kanigel

21W.899 Special Graduate Elective in Science Writing
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit

Elective choices and sequences arranged by staff to complement the enrolled students’ program of research and study.

R. Kanigel

21W.ThG Graduate Thesis
Prereq: Permission of instructor
G (Fall, Spring)
6-0-18 H-LEVEL Grad Credit
Can be repeated for credit

Research and writing of thesis in consultation with faculty, including individual meetings and group seminars, undertaken over the course of one year.

R. Kanigel
# Bachelor of Science in Writing/Course 21W

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
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<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement (three subjects may be satisfied by subjects in the Departmental Program)</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
</tbody>
</table>

Total GIR Subjects Required for SB Degree: 17

## Communication Requirement

The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H), and 2 subjects designated as Communication Intensive in the Major (CI-M).

## PLUS Departmental Program Units

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

### Option 1: Creative Writing (fiction, nonfiction, poetry)

**Required Subjects** 18

- 21W.ThT Writing and Humanistic Studies Pre-Thesis Tutorial, 6
- 21W.ThU Writing and Humanistic Studies Thesis, 12, CI-M; 21W.ThT

One of the following (CI-M): 21W.757, 21W.758, 21W.759, 21W.762, 21W.766I, 21W.770, 21W.771, 21W.777, or 21W.ThT

**Restricted Electives** 90–120

Seven subjects centered on creative writing, of which one is normally introductory; three subjects in literature, one of which may be in CMS.

### Option 2: Science Writing

**Required Subjects** 54

- 21W.778 Science Journalism, 12, HASS, CI-H
- 21W.792 Science Writing Internship, 12, HASS
- 21W.ThT Writing and Humanistic Studies Pre-Thesis Tutorial, 6
- 21W.ThU Writing and Humanistic Studies Thesis, 12, CI-M; 21W.ThT

One of the following (CI-M): 21W.757, 21W.758, 21W.759, 21W.762, 21W.766I, 21W.770, 21W.771, 21W.777, or 21W.ThT

**Restricted Electives** 60

Four subjects in writing, of which one is normally introductory; three are writing subjects approved for this major, one of which is in digital media (48 units). One approved Science, Technology, and Society subject (12 units).

### Option 3: Digital Media

**Required Subjects** 54

- 21W.764 The Word Made Digital, 12, HASS
- 21W.765 Interactive and Non-Linear Narrative: Theory and Practice, 12, HASS
- 21W.785 Communicating with Web-based Media, 12, HASS, CI-H
- 21W.ThT Writing and Humanistic Studies Pre-Thesis Tutorial, 6
- 21W.ThU Writing and Humanistic Studies Thesis, 12, CI-M; 21W.ThT

One of the following (CI-M): 21W.757, 21W.758, 21W.759, 21W.762, 21W.766I, 21W.770, 21W.771, 21W.777, or 21W.ThT

**Restricted Electives** 63–84

Four subjects in writing, which may be in digital media, creative writing, or science writing, and three related subjects from any of the following courses: 6, 21L, MAS, STS, or CMS

## Departmental Program Units That Also Satisfy the GIRs

(27–36)

**Unrestricted Electives**

<table>
<thead>
<tr>
<th>Option</th>
<th>Units</th>
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<tbody>
<tr>
<td>Option 1</td>
<td>42–72</td>
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<tr>
<td>Option 2</td>
<td>66</td>
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<tr>
<td>Option 3</td>
<td>42–63</td>
</tr>
</tbody>
</table>

Total Units Beyond the GIRs Required for SB Degree: 180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

## Notes

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
UNDERGRADUATE SUBJECTS

22.00 Introduction to Modeling and Simulation
Engineering School-Wide Elective Subject
(Offered under: 1.021, 3.021, 10.333, 22.00)
Prereq: 18.03, 3.016, or permission of instructor
U (Spring)
4-0-8 REST

See description under subject 3.021.
M. Buehler, N. Marzari, R. Radovitzky,
T. Thonhauser

22.002J Communicating About Technology: Colossal Failures in Engineering
(Same subject as 1.588J, 3.070J, 21W.781J,
ESD.032J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS, CI-H

See description under subject 21W.781J.
T. Eagar, W. Haas, A. Kadak, P. Lagacé,
O. Buyukozturk

22.01 Introduction to Ionizing Radiation
Prereq: None
U (Fall)
2-0-4

Introduction to basic properties of ionizing radiations and their uses in medicine, industry, science, and environmental studies. Discusses natural and man-made radiation sources, energy deposition and dose calculations, various physical, chemical, and biological processes and effects of radiation with examples of their uses, and principles of radiation protection.
J. C. Yanch

22.011 Seminar in Nuclear Science and Engineering
Prereq: None
U (Fall)
2-0-4

Surveys the range of diverse subjects in nuclear science and engineering covered by the department. Topics include quantum computing, energy and power, radiation effects-stem cells and DNA, BNCT, nuclear space applications, fusion, airport security, accelerators, magnetic resonance imaging, non-proliferation, risk assessment, safety, biology and medicine. A demonstration of the MIT Reactor as a research tool is given as well as a tour of the MIT Tokomak fusion machine and accelerators used in research.
G. Apostolakis

22.012 Seminar in Fusion and Plasma Physics
Prereq: None
U (Spring)
2-0-4

Lectures and discussion introducing the range of topics relevant to plasma physics and fusion engineering. Introductory discussion of the economic and ecological motivation for the development of fusion power. Contemporary magnetic confinement schemes, theoretical questions, and engineering considerations are presented by expert guest lecturers. Tour of Plasma Science and Fusion Center experimental facilities.

22.013 Applications of Radiation Science and Technology in Biomedical Research
Prereq: None
U (Fall)
2-0-4

Seminar lectures, led by practicing clinicians and scientists in a case presentation format, on current research topics and specific projects in the biomedical field in which radiation science and radiological engineering play an important role. Emphasis on nuclear imaging techniques such as magnetic resonance and positron emission tomography, and on radiation therapy. Term paper required. Lectures shared with freshman advisor seminar 22.A09 Career Options for Biomedical Research.
S. Yip, B. Rosen

22.02 Introduction to Applied Nuclear Physics
Prereq: Physics II (GIR), Calculus II (GIR)
U (Spring)
5-0-7 REST

Basic concepts of nuclear physics with emphasis on nuclear structure and interactions of radiation with matter. Elementary quantum theory; nuclear forces; shell structure of the nucleus; alpha, beta, and gamma, radioactive decays; interactions of nuclear radiations (charged particles, gammas and neutrons) with matter; nuclear reactions; fission and fusion.
P. Cappellaro

22.033 Nuclear Systems Design Project
(Subject meets with 22.33)
Prereq: 22.06
U (Fall)
3-0-9

See description under subject 22.33.
A. Kadak

22.05 Neutron Science and Reactor Physics
Prereq: 22.02, 18.03
U (Fall)
5-0-7

Introduces fundamental properties of the neutron. Covers reactions induced by neutrons, nuclear fission, slowing down of neutrons in infinite media, diffusion theory, the few-group approximation, point kinetics, and fission-product poisoning. Emphasizes the nuclear physics bases of reactor design and its relationship to reactor engineering problems.
B. Forget

22.055 Radiation Biophysics (New)
(Subject meets with 22.55J, HST.560J)
Prereq: Permission of instructor
U (Spring)
3-0-9

See description under subject 22.55J.
J. C. Yanch

22.058 Radiation Systems Engineering and Tomographic Imaging
Prereq: 18.03, Physics II (GIR)
U (Fall)
3-3-6

An introduction to radiation systems engineering with examples taken from tomographic imaging. Includes a series of lectures with a parallel set of recitations that provide demonstrations of basic principles. Both ionizing and non-ionizing radiation are covered, including x-ray, PET, MRI, and ultrasound. Emphasis is on the physics and engineering of image formation.
D. Cory
of energy propositions within an engineering, economic and social context. Students taking graduate version complete additional assignments. Limited to juniors and seniors.

* M. W. Golay, J. P. Freidberg*

### 22.096 Quantum Mechanics for Nuclear Engineers

(Subject meets with 22.96)

Prereq: None

U (IAP)

1-0-2

Introduction to wave mechanics using optical analogies and examples from nuclear science to gain an intuitive understanding of quantum phenomena. Topics include wave optics and mechanics, the Schrodinger equation and its solution in one dimension, the tunnel effect and radioactive decay, the deuteron and neutron-proton scattering. Math skills introduced as required. Lectures and computer simulation demonstrations. Meets with graduate subject 22.96, but assignments differ. Graduate students are expected to explore the subject in greater depth.

* S. H. Chen*

### 22.097 Quantum Mechanics for Nuclear Engineers

(Subject meets with 22.97)

Prereq: None

U (Spring)

4-0-1

Introduction to wave mechanics for nuclear engineers. Engineering in nuclear energy plant design, accelerators and fusion machines. Using the basic principles of nuclear physics, reactor physics, plasma physics and magnetic confinement, heat transfer, safety, risk and reliability, the engineering design of nuclear power plants, accelerators and fusion systems are studied. The MIT reactor, department accelerators, and MIT’s Alcator fusion facility are used.

* J. Buongiorno*

### 22.070 Materials for Nuclear Applications (New)

(Subject meets with 22.70)

Prereq: Permission of instructor

U (Spring)

3-0-9

Introductory subject for students who are not specializing in nuclear materials. Applications and selection of materials for use in nuclear applications. Radiation damage, radiation effects, and their effects on performance of materials in fission and fusion environments. Students taking graduate version complete additional assignments. Preference to juniors and seniors.

* B. Yildiz*

### 22.071J Electronics, Signals, and Measurement

(Same subject as 6.071J)

Prereq: 18.03

U (Spring)

3-3-6 REST

See description under subject 6.071J.

* I. Hutchinson*

### 22.081J Introduction to Sustainable Energy (New)

(Same subject as 2.650J, 10.291J)

(Subject meets with 1.818J, 2.65J, 10.391J, 11.371J, 22.811J, ESD.166J)

Prereq: Permission of instructor

U (Fall)

3-1-8

Assessment of current and potential future energy systems. Covers resources, extraction, conversion, and end-use technologies, with emphasis on meeting 21st-century regional and global energy needs in a sustainable manner. Examines various renewable and conventional energy production technologies, energy end-use practices and alternatives, and consumption practices in different countries. Investigates their attributes within a quantitative analytical framework for evaluation of energy technology system proposals. Emphasizes analysis nature in the field of nuclear engineering. In close cooperation with individual staff members. Topics and hours arranged to fit students’ requirements.

* D. Whyte*

### 22.06 Engineering of Nuclear Systems

Prereq: 2.005, 22.05

U (Spring)

3-0-9

Introduces engineering in nuclear energy plant design, accelerators and fusion machines. Using the basic principles of nuclear physics, reactor physics, plasma physics and magnetic confinement, heat transfer, safety, risk and reliability, the engineering design of nuclear power plants, accelerators and fusion systems are studied. The MIT reactor, department accelerators, and MIT’s Alcator fusion facility are used.

* J. Buongiorno*

### 22.09 Principles of Nuclear Radiation Measurement and Protection

(Subject meets with 22.90)

Prereq: 22.02

U (Spring)

2-6-4 Institute LAB

Combines lectures, demonstrations, and experiments. Review of radiation protection procedures and regulations; theory and use of alpha, beta, gamma, and neutron detectors; applications in imaging and dosimetry; gamma-ray spectroscopy; design and operation of automated data acquisition experiments using virtual instruments. Meets with graduate subject 22.90, but homework assignments and examinations differ. Instruction and practice in written communication provided.

* J. C. Vanch, R. C. Lanza, L. Hobbs*

### 22.091 Special Topics in Nuclear Science and Engineering

Prereq: None

U (Fall, IAP, Spring, Summer)

See description under subject 22.091.

### 22.092 Special Topics in Nuclear Science and Engineering

Prereq: Permission of Course 22 undergraduate office

U (Fall)

1-0-2

This subject is graded on a P/D/F basis and is otherwise equivalent to subject 22.091.

* D. Whyte*

### 22.093 Special Topics in Nuclear Science and Engineering

Prereq: Permission of Course 22 undergraduate office

U (Fall, IAP, Spring, Summer)

Units arranged

Can be repeated for credit

This subject is graded on a P/D/F basis and is otherwise equivalent to subject 22.091.

* D. Whyte*

### 22.094 Special Topics in Nuclear Science and Engineering

Prereq: None

U (Fall, IAP, Spring, Summer)

Units arranged

Can be repeated for credit

For undergraduates who wish to conduct a one-term project of theoretical or experimental nature in the field of nuclear engineering, in close cooperation with individual staff members. Topics and hours arranged to fit students’ requirements.

* D. Whyte*
22.09 Undergraduate Thesis Tutorial
Prereq: 22.09
U (Fall)
1-0-2 [P/D/F]
A series of lectures on prospectus and thesis writing. Students select a thesis topic and a thesis advisor who reviews and approves the prospectus for thesis work in the spring term.
Staff

22.101 Electromagnetic Interactions
Prereq: Physics II (GIR), 8.03, Calculus II (GIR), 18.03
G (Fall)
3-0-9 H-LEVEL Grad Credit
D. Whyte

22.211 Nuclear Reactor Physics I
Prereq: 18.075
G (Spring)
3-0-9 H-LEVEL Grad Credit
Reviews the physics basis for modern nuclear reactor design. Topics include the continuous energy transport equation and its adjoint; reduction to diffusion theory and the group diffusion equations; calculation of neutron spectra and determination of few group diffusion constants.

22.251 Systems Analysis of the Nuclear Fuel Cycle
Prereq: 22.05
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-2-7 H-LEVEL Grad Credit
Study of the relationship between the technical and policy elements of the nuclear fuel cycle. Topics include uranium supply, enrichment, fuel fabrication, in-core reactivity and fuel management of uranium and other fuel types, used fuel reprocessing and waste disposal. Principles of fuel cycle economics and the applied reactor physics of both contemporary and proposed thermal and fast reactors are presented. Nonproliferation aspects, disposal of excess weapons plutonium, and transmutation of long lived radioisotopes in spent fuel are examined. Several state-of-the-art computer programs relevant to reactor core physics and heat transfer are provided for student use in problem sets and term papers.
M. S. Kazimi

22.212 Engineering of Nuclear Reactors
Prereq: 2.001 and 2.005, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Engineering principles of nuclear reactors, emphasizing power reactors. Power plant thermodynamics, reactor heat generation and removal (single-phase as well as two-phase coolant flow and heat transfer), and structural mechanics. Engineering considerations in reactor design.
J. Buongiorno

22.313 Thermal Hydraulics in Power Technology
(See subject as 2.59, 10.536)
Prereq: 2.006, 10.302, 22.312, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-2-7 H-LEVEL Grad Credit
nels connected at plena. Loop analysis including single and two-phase natural circulation. Sub-channel analysis.

M. S. Kazimi, N. E. Todreas

22.314 Structural Mechanics in Nuclear Power Technology
(Same subject as 1.56j, 2.084j)
Prereq: 2.001 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Structural components in nuclear power plant systems, their functional purposes, operating conditions, and mechanical/structural design requirements. Combines mechanics techniques with models of material behavior to determine adequacy of component design. Considerations include mechanical loading, brittle fracture, inelastic behavior, elevated temperatures, neutron irradiation, vibrations and seismic effects.

M. S. Kazimi, O. Buyukozturk

22.33 Nuclear Engineering Design
(Subj ect meets with 22.033)
Prereq: 22.312
G (Fall)
3-0-9 H-LEVEL Grad Credit

Group design project involving integration of nuclear physics, particle transport, control, heat transfer, safety, instrumentation, materials, environmental impact, and economic optimization. Provides opportunity to synthesize knowledge acquired in nuclear and non-nuclear subjects and apply this knowledge to practical problems of current interest in nuclear applications design. Past projects have included using a fusion reactor for transmutation of nuclear waste, design and implementation of an experiment to predict and measure pebble flow in a pebble bed reactor, and development of a mission plan for a manned Mars mission including the conceptual design of a nuclear powered space propulsion system and power plant for the Mars surface. Meets with undergraduate subject 22.033, but assignments differ.

A. Kadak

22.38 Probability and Its Applications To Reliability, Quality Control, and Risk Assessment
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit


22.39 Integration of Reactor Design, Operations, and Safety
Prereq: 22.211, 22.312
G (Fall)
3-2-7 H-LEVEL Grad Credit

Integration of reactor physics and engineering sciences into nuclear power plant design focusing on designs that are projected to be used in the first half of this century. Topics include materials issues in plant design and operations, aspects of thermal design, fuel depletion and fissile-product poisoning, and temperature effects on reactivity. Safety considerations in regulations and operations such as the evolution of the regulatory process, the concept of defense in depth, general design criteria, accident analysis, probabilistic risk assessment, and risk-informed regulations.

G. Apostolakis

22.40 Fundamentals of Advanced Energy Conversion
(Same subject as 2.62j, 3.64j, 10.392j)
(Subject meets with 2.60j, 3.083j)
Prereq: 2.006, 3.044, or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit

See description under subject 2.62j.

A. F. Ghoniem, M. Kazimi, Y. Chiang

22.51 Quantum Theory of Radiation Interactions
Prereq: 22.101, 22.105
G (Fall)
3-0-9 H-LEVEL Grad Credit

Introduces elements of applied quantum mechanics and statistical physics. Starting from the experimental foundation of quantum mechanics, develops the basic principles of interaction of electromagnetic radiation with matter. Introduces quantum theory of radiation, time-dependent perturbation theory, transition probabilities and cross sections. Applications are to controlling coherent and decoherent dynamics with examples from quantum information processing.

R. Cappellaro

22.52 Statistical Thermodynamics of Complex Liquids
(Same subject as 8.575j, 10.44j)
Prereq: 8.08, 10.213
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit

See description under subject 10.44j.

22.53 Statistical Processes and Atomistic Simulations
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit


S. Yip

22.55 Radiation Biophysics
(Same subject as HST.606j)
(Subject meets with 22.055)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Provides a background in sources of radiation with an emphasis on terrestrial and space environments and on industrial production. Discusses experimental approaches to evaluating biological effects resulting from irradiation regimes differing in radiation type, dose and dose-rate. Effects at the molecular, cellular, organism, and population level are examined. Literature is reviewed identifying gaps in our understanding of the health effects of radiation, and responses of regulatory bodies to these gaps is discussed. Students taking graduate version complete additional assignments.

J. C. Yanch
22.561 Noninvasive Imaging in Biology and Medicine
(Same subject as 9.173J, 20.483J, HST.561J)
Prereq: 18.03, 8.03, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Background in the theory and application of noninvasive imaging methods in biology and medicine, with emphasis on neuroimaging. Focuses on the modalities most frequently used in scientific research (x-ray CT, PET/SPECT, MRI, and optical imaging), and includes discussion of molecular imaging approaches used in conjunction with these scanning methods. Lectures are supplemented by in-class discussions of problems in research and demonstrations of imaging systems.
A. Jasanoff

22.561J Magnetic Resonance Analytic, Biochemical, and Imaging Techniques
(Same subject as HST.584J)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-12 H-LEVEL Grad Credit
See description under subject HST.584J.
B. R. Rosen

22.562 Spatial Aspects of Nuclear Magnetic Resonance Spectroscopy
Prereq: 18.03, 8.05
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Discusses the theory and application of nuclear magnetic resonance spectroscopy to questions of the spatial distribution of spins. Covers NMR imaging, localized spectroscopy, and local geometries as determined by diffusive processes. The theory is discussed in terms of the density operator and reciprocal space (for both imaging and motional studies). Describes applications to rapid imaging, dynamic imaging, microscopy, and localized spectroscopy. Instrumentation and experimental constraints are also described.
D. G. Cory

22.563 Engineering Principles for Fusion Reactors
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
D. Whyte

22.611J Introduction to Plasma Physics I
(Same subject as 6.651J, 8.613J)
Prereq: 6.013, 8.07, or 22.105; 18.04 or Coreq: 18.075
G (Fall)
3-0-9 H-LEVEL Grad Credit
J. Egedal-Pedersen

22.612J Introduction to Plasma Physics II
(Same subject as 6.652J, 8.614J)
Prereq: 6.651J, 8.613J, or 22.611J
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 8.614J.
Staff

22.615 MHD Theory of Fusion Systems
Prereq: 22.611J, 6.651J, or 8.613J
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Discussion of MHD equilibria in cylindrical, toroidal, and noncircular configurations. MHD stability theory including the Energy Principle, interchange instability, ballooning modes, second region of stability, and external kink modes. Description of current configurations of fusion interest.
J. P. Freidberg

22.616 Plasma Transport Theory
Prereq: 22.615
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
The Fokker-Planck operator for Coulomb collisions, including the Landau and Rosenbluth potential forms, is derived, expanded to obtain useful limits, and used to define characteristic times. Classical collisional transport in an arbitrary magnetic field is developed first, and then the high (Pfirsch-Schluter), low (banana), and intermediate (plateau) collisionality regimes of tokamak transport are examined with emphasis on the banana regime where bootstrap current is most pronounced. Gyrokinetics and zonal flow is discussed.
P. Catto

22.62 Fusion Energy
Prereq: 22.611J
G (Spring)
3-0-9 H-LEVEL Grad Credit
Basic nuclear physics and plasma physics for controlled fusion. Fusion cross-sections and consequent conditions required for ignition and energy production. Principles of magnetic and inertial confinement. Description of magnetic confinement devices: tokamaks, stellarators and RFPs, their design and operation. Elementary plasma stability considerations and the limits imposed. Plasma heating by neutral beams and RF. Outline design of the ITER “burning plasma” experiment and a magnetic confinement reactor.
J. Freidberg

22.63 Principles of Plasma Diagnostics
Prereq: 6.651J, 8.613J, or 22.611J
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Introduction to the physical processes used to measure the properties of plasmas, especially fusion plasmas. Measurements of magnetic and electric fields, particle flux, refractive index, emission and scattering of electromagnetic waves and heavy particles; their use to deduce plasma parameters such as particle density, pressure, temperature, and velocity, and hence the plasma confinement properties. Discussion of practical examples and assessments of the accuracy and reliability of different techniques.
I. H. Hutchinson
Nuclear Materials

22.70 Materials for Nuclear Applications
(Subject meets with 22.070)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.070.
B. Yildiz

22.71 Modern Physical Metallurgy
(Same subject as 3.40)
(Subject meets with 3.14)
Prereq: 3.012, 3.022, 3.032
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 3.40.
R. Schuh

22.72 Corrosion: The Environmental Degradation of Materials
(Same subject as 3.54)
Prereq: 3.012
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 3.54.
R. G. Ballinger

22.76 Nuclear Chemical Engineering
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-1-8 H-LEVEL Grad Credit
B. Yildiz

22.77 Nuclear Waste Management
Prereq: 22.76 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduces scientific and engineering aspects of the management of spent fuel, reprocessed high-level waste, low-level wastes, and decommissioning wastes. Characteristics and classification of nuclear wastes and waste forms.
R. K. Lester

R. K. Lester

Systems, Policy, and Economics

22.811J Sustainable Energy (10.391)
(Same subject as 1.818J, 2.65J, 10.391, 11.371J, ESD.166J)
(Subject meets with 2.650J, 10.291J, 22.081J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
Assessment of current and potential future energy systems. Covers resources, extraction, conversion, and end-use technologies, with emphasis on meeting 21st-century regional and global energy needs in a sustainable manner. Examines various energy technologies in each fuel cycle stage for fossil (oil, gas, synthetic), nuclear (fission and fusion) and renewable (solar, biomass, wind, hydro, and geothermal) energy types, along with storage, transmission, and conservation issues. Emphasizes analysis of energy propositions within an engineering, economic and social context. Students taking graduate version complete additional assignments.
M. W. Golay, J. P. Freidberg

22.813 Applications of Technology in Energy and the Environment
Engineering School-Wide Elective Subject
(Offered under: 1.149, 2.63J, 5.00, 10.379, 22.813, ESD.174)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduces advanced undergraduates or graduate students in the Schools of Engineering and Science to the integration of technical, economic, political, and environmental consideration required for the successful implementation of new technology. Case studies are drawn from the energy and environment sectors with some emphasis on analytic techniques that serve as a “tool box” for students. Technologies considered include fossil, nuclear, solar, wind, fuel cell and energy conservation. International aspects, such as weapons proliferation and global climate effects, also discussed. Enrollment limited.
J. Deutch, R. Lester

22.82 Engineering Risk-Benefit Analysis
Engineering School-Wide Elective Subject
(Offered under: 1.155, 2.963, 3.577, 6.938, 10.816, 16.862, 22.82, ESD.72)
Prereq: Calculus II (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.72.
G. E. Apostolakis

General

22.90 Nuclear Science and Engineering Laboratory
(Subject meets with 22.09)
Prereq: 22.101
G (Spring)
2-6-4 H-LEVEL Grad Credit
See description under subject 22.09.
J. C. Yanch, R. C. Lanza, L. Hobbs

22.901–22.904 Special Problems in Nuclear Science & Engineering
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
For graduate and advanced undergraduate students who wish to conduct a one-term project of a theoretical or experimental nature in the nuclear engineering field, in close cooperation with individual staff members. Arrangement of topic and hours to fit students’ requirements.
J. C. Yanch

Course 22
22.905 Special Topics in Nuclear Science and Engineering
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Special topics for graduate and advanced undergraduate students.
J. C. Yanch

22.911 Seminar in Nuclear Science and Engineering
Prereq: None
G (Fall)
2-0-1 [P/D/F]
Can be repeated for credit

22.912 Seminar in Nuclear Science and Engineering
Prereq: None
G (Spring)
2-0-1 [P/D/F]
Can be repeated for credit
Restricted to graduate students engaged in doctoral thesis research.
A. Kadak, J. C. Yanch, J. Freidberg

22.915 Seminar in Magnetic Resonance
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
2-0-1 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Discusses current topics in magnetic resonance including research issues by graduate students and staff members.
D. G. Cory

22.920 Interactive Introduction to Nuclear Magnetic Resonance
(Same subject as 8.22J)
Prereq: Calculus II (GIR)
G (IAP)
1-2-0 H-LEVEL Grad Credit
Interactive introduction to NMR presenting background in classical theory and instrumentation. Each lecture followed by lab experiments both to demonstrate ideas presented during the lecture and to familiarize students with state-of-the-art NMR instrumentation. Experiments cover topics ranging from spin dynamics to spectroscopy, and include both imaging and quantum information processing.
D. G. Cory

22.921 Nuclear Power Plant Dynamics and Control
Prereq: None
G (IAP)
1-0-2
Introduction to reactor dynamics including subcritical multiplication, critical operation in absence of thermal feedback effects and effects of xenon, fuel and moderator temperature, etc. Derivation of point kinetics and dynamic period equations. Techniques for reactor control including signal validation, supervisory algorithms, model-based trajectory tracking, and rule-based control. Overview of light-water reactor startup. Lectures and demonstrations with use of the MIT Research Reactor. Open to undergraduates with permission of instructor.
J. A. Bernard

22.93 Teaching Experience in Nuclear Science and Engineering
Prereq: Permission of department
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
For qualified graduate students interested in teaching as a career. Classroom, laboratory, or tutorial teaching under the supervision of a faculty member. Students selected by interview. Credits for this subject may not be used toward master’s or engineer’s degrees. Enrollment limited by the availability of suitable assignments.
I. H. Hutchinson

22.94 Research in Nuclear Science and Engineering
Prereq: Permission of research supervisor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
For research assistants in Nuclear Science and Engineering who have not completed the NSE doctoral qualifying exam. Hours arranged with and approved by the research supervisor. Units may not be used towards advanced degree requirements.
J. C. Yanch

22.96 Quantum Mechanics for Nuclear Engineers
(Subject meets with 22.096)
Prereq: None
G (IAP)
1-0-2
See description under subject 22.096.
S. H. Chen
Bachelor of Science in Nuclear Science and Engineering/Course 22

**General Institute Requirements (GIRs)**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>[can be satisfied from among 8.03; 18.03 or 18.034; 22.01; 22.02; and 22.071J, in the Departmental Program]</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

**Communication Requirement**

The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the major (CI-M).

**PLUS Departmental Program**

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics)</td>
</tr>
</tbody>
</table>

**Basic Requirements**

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.005 Thermal-Fluids Engineering I, 12; REST; Physics II (GIR), Calculus II (GIR), 18.03</td>
</tr>
<tr>
<td>6.00 Introduction to Computer Science and Programming, 12, REST</td>
</tr>
<tr>
<td>or 12.010 Computational Methods of Scientific Programming, 12; Calculus I (GIR), Calculus II (GIR), Physics I (GIR)</td>
</tr>
<tr>
<td>8.03 Physics III, 12, REST; Physics II (GIR), Calculus II (GIR)</td>
</tr>
<tr>
<td>18.03 Differential Equations, 12, REST; Calculus II (GIR)</td>
</tr>
<tr>
<td>or 18.034 Differential Equations, 12, REST, Calculus II (GIR)</td>
</tr>
<tr>
<td>18.085 Computational Science and Engineering I, 12; Calculus II (GIR), 18.03*</td>
</tr>
<tr>
<td>22.01 Introduction to Ionizing Radiation, 12, REST</td>
</tr>
<tr>
<td>22.071J Electronics, Signals, and Measurement, 12, REST; 18.03</td>
</tr>
</tbody>
</table>

**Required Nuclear Science and Engineering Core Subjects**

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>22.02 Introduction to Applied Nuclear Physics, 12, REST; Physics II (GIR), Calculus II (GIR)</td>
</tr>
<tr>
<td>22.035 Nuclear Systems Design Project, 12; 22.06</td>
</tr>
<tr>
<td>22.05 Neutron Science and Reactor Physics, 12; 18.03, 22.02</td>
</tr>
<tr>
<td>22.09 Principles of Nuclear Radiation Measurement and Protection, 12, LAB, CI-M; 22.02</td>
</tr>
</tbody>
</table>

Choose two of the following:

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>22.058 Principles of Tomographic Imaging, 12; Physics II (GIR), 18.03</td>
</tr>
<tr>
<td>22.055 Radiation Biophysics, 12; permission of instructor</td>
</tr>
<tr>
<td>22.05 Radiation Health Physics, 12; 2.005, 22.05</td>
</tr>
<tr>
<td>22.070 Materials for Nuclear Applications, 12; permission of instructor</td>
</tr>
</tbody>
</table>

**Required Undergraduate Nuclear Science and Engineering Thesis**

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>22.6ThT Undergraduate Thesis Tutorial (minimum of 3 units); 22.09</td>
</tr>
<tr>
<td>22.6ThU Undergraduate Thesis (minimum of 9 units), CI-M; 22.6ThT</td>
</tr>
</tbody>
</table>

**Departmental Program Units That Also Satisfy the GIRs**

<table>
<thead>
<tr>
<th>Units</th>
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<tr>
<td>(36)</td>
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**Unrestricted Electives**

<table>
<thead>
<tr>
<th>Units</th>
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<tr>
<td>60</td>
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**Total Units Beyond the GIRs Required for SB Degree**

<table>
<thead>
<tr>
<th>Units</th>
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<tr>
<td>192</td>
</tr>
</tbody>
</table>

No subject can be counted both as part of the 17-subject GIRs and as part of the 192 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

**Notes**

*Alternate prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help in the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
PHILOSOPHY

24.00 Problems of Philosophy
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 2, CI-H

Introduction to the problems of philosophy—in particular, to problems in ethics, metaphysics, theory of knowledge, and philosophy of logic, language, and science. A systematic rather than historical approach. Readings from classical and contemporary sources, but emphasis is on examination and evaluation of proposed solutions to the problems.
S. Yablo

24.01 Classics of Western Philosophy
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 2, CI-H

Introduction to Western philosophical tradition through the study of selected major thinkers such as Plato, Aristotle, Descartes, Hobbes, Leibniz, Locke, Berkeley, Hume, Kant, Nietzsche and Marx. Emphasis on changes of intellectual outlook over time, and the complex interplay of scientific, religious and political concerns that influence the development of philosophical ideas.
R. Langton

24.02 Moral Problems and the Good Life
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 2, CI-H

Introduction to important philosophical debates about moral issues and what constitutes a good life: What is right, what is wrong, and why? How important are personal happiness, longevity, and success if one is to live a good life? When is it good for you to get what you want? To what extent are we morally obliged to respect the rights and needs of others? What do we owe the poor, the discriminated, our loved ones, animals and fetuses?
S. Haslanger

24.03J Justice
(Same subject as 17.01J)
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 2, CI-H

An examination of alternative theories of justice—utilitarianism, rights theories, social contract theory, and communitarianism—and the implications of those theories for problems of liberty, equality, and community. Readings drawn principally from the work of contemporary political philosophers, including Rawls, Nozick, Dworkin, Walzer, MacIntyre, and Buchanan.
Staff

24.06J Bioethics
(Same subject as STS.006J)
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 2, CI-H

Considers ethical questions that have arisen from the growth of biomedical research and the health-care industry since World War II. Should doctors be allowed to help patients end their lives? If so, when and how? Should embryos be cloned for research and/or reproduction? Should parents be given control over the genetic make-up of their children? What types of living things are appropriate to use as research subjects? How should we distribute scarce and expensive medical resources? Draws on philosophy, history, and anthropology to show how problems in bioethics can be approached from a variety of perspectives.
C. Hare, D. Jones

24.07J Philosophical Issues in Brain Science
(Same subject as 9.48J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS-D, Category 2, CI-H

An introduction to some central philosophical questions about the mind, specifically those intimately connected with contemporary psychology and neuroscience. Discussions focus on arguments over innate concepts; “mental images” as pictures in the head; whether color is in the mind or in the world; and whether there can be a science of consciousness. Explains the relevant parts of psychology and neuroscience as the subject proceeds.
A. Byrne, P. Sinha

24.09 Minds and Machines
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 2, CI-H

Introduction to philosophy of mind. Can computers think? Is the mind an immaterial thing? Alternatively, is the mind the brain? How can creatures like ourselves think thoughts that are about things? Can I know whether your experiences are the same as mine when we both look at raspberries, fire trucks, and stoplights? Can consciousness be given a scientific explanation?
M. Montague

24.111 Philosophy of Quantum Mechanics
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

Quantum mechanics is said to describe a world in which physical objects often lack “definite” properties, indeterminism creeps in at the point of “observation,” ordinary logic does not apply, and distant events are perfectly yet inexplicably correlated. Examination of these and other issues central to the philosophical foundations of quantum mechanics, with special attention to the measurement problem, no-hidden-variables proofs, and Bell's Inequalities. Rigorous approach to the subject matter nevertheless neither presupposes nor requires the development of detailed technical knowledge of the quantum theory.
B. Skow

24.112 Space, Time, and Relativity
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Philosophical questions raised by relativistic and pre-relativistic physics, especially questions about space and time. Discussions focus on Newton's arguments for the existence of absolute space and time; pre-relativistic arguments that the geometry of space is a matter of convention; and counter arguments from
relativity showing that the passage of time is not a real phenomenon. Other topics include the relationship between matter and energy in relativity, and the possibility of time travel. Previous exposure to special relativity will be helpful but is not required.

B. Skow

24.114 A Philosophical History of Energy
(Same subject as 10.04j)
Prereq: None
U (Spring)
3-0-9 HASS
See description under subject 10.04j.
B. L. Trout, L. D. Perlman

24.118 Paradox and Infinity
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Different kinds of infinity; the paradoxes of set theory; the reduction of arithmetic to logic; formal systems; paradoxes involving the concept of truth; Gödel's incompleteness theorems; the nonformalizable nature of mathematical truth; and Turing machines.
A. Rayo

24.120 Moral Psychology
Prereq: None
U (Fall)
3-0-9 HASS
An examination of philosophical theories of action and motivation in the light of empirical findings from social psychology, sociology and neuroscience. Topics include belief, desire, and moral motivation; sympathy and empathy; intentions and other committing states; strength of will and weakness of will; free will; addiction and compulsion; guilt, shame and regret; evil; self-knowledge and self-deception; virtues and character traits.
R. Holton

24.201 Topics in the History of Philosophy
Prereq: One HASS-D in philosophy or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Can be repeated for credit with permission of instructor and advisor
Close examination of a text, an author, or a theme in the history of philosophy.
S. Haslanger

24.209 Philosophy in Film and Other Media
Prereq: None
U (Fall)
3-0-9 HASS
Works of film examined in relation to thematic issues of philosophical importance that also occur in other arts, particularly literature and opera. Emphasis on film's ability to represent and express feeling as well as cognition.
I. Singer

24.211 Theory of Knowledge
Prereq: One philosophy subject
U (Spring)
3-0-9 HASS
Study of problems concerning our concept of knowledge, our knowledge of the past, our knowledge of the thoughts and feelings of ourselves and others, and our knowledge of the existence and properties of physical objects in our immediate environment.
R. White

24.213 Philosophy of Film
(Subject meets with CMS.820)
Prereq: None
U (Spring)
3-0-9 HASS
Philosophical analysis of film art, with an emphasis on the ways in which it creates meaning through techniques that define a formal structure. Particular focus on aesthetic problems about appearance and reality, literary and visual effects, communication and alienation through film technology.
I. Singer

24.214 Introduction to Philosophy of the Arts
(Subject meets with CMS.811)
Prereq: None
U (Fall)
3-0-9 HASS
Interdisciplinary introduction to principles of aesthetics in arts such as literature, film, music, and the media arts. Topics include the nature of imagination and creativity, and the role of art and aesthetics in science, ethics, and religion. Relevant screenings as well as readings. Students taking graduate version complete additional assignments.
I. Singer

24.215 Topics in the Philosophy of Science
Prereq: One philosophy subject
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Can be repeated for credit
Close examination of a small number of issues central to recent philosophy of science, such as the demarcation problem, causal relations, laws of nature, underdetermination of theory by data, paradoxes of confirmation, scientific realism, the role of mathematics in science, elimination of bias, and the objectivity of scientific discourse.
R. White

24.221 Metaphysics
Prereq: One philosophy subject
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Study of basic metaphysical issues concerning existence, the mind-body problem, personal identity, and causation plus its implications for freedom. Classical as well as contemporary readings. Provides practice in written and oral communication.
Staff

24.222 Decisions, Games and Rational Choice
Prereq: None
U (Spring)
3-0-9 HASS
Foundations and philosophical applications of Bayesian decision theory, game theory and theory of collective choice. Why should degrees of belief be probabilities? Is it always rational to maximize expected utility? If so, why and what is its utility? What is a solution to a game? What does a game-theoretic solution concept such as Nash equilibrium say about how rational players will, or should, act in a game? How are the values and the actions of groups, institutions and societies related to the values and actions of the individuals that constitute them?
R. Stalnaker

24.231 Ethics
Prereq: One philosophy subject
U (Fall)
3-0-9 HASS
Systematic study of central theories in ethics, including egoism, act and rule utilitarianism, intuitionism, emotivism, rights theories, and contractualism. Discussion and readings also focus on problems associated with moral conflicts, justice, the relationship between rightness and
goodness, objective vs. subjective moral judgments, moral truth, and relativism.

Staff

24.235j Philosophy of Law
(Same subject as 17.021j)
Prereq: One philosophy subject or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Examination of fundamental issues in philosophy of law, such as the nature and limits of law and a legal system, and the relation of law to morality, with particular emphasis on the philosophical issues and problems associated with privacy, liberty, justice, punishment, and responsibility. Historical and contemporary readings, including court cases.
Staff

24.237 Feminist Theory
(Subject meets with 17.006, 17.007, SP.601)
Prereq: None
U (Spring)
3-0-9 HASS
See description under subject SP.601.
E. Wood

24.241 Logic I
Prereq: None
U (Fall)
3-0-9 HASS
Introduction to the aims and techniques of formal logic. The logic of truth functions and quantifiers. The concepts of validity and truth and their relation to formal deduction. Applications of logic and the place of logic in philosophy.
Staff

24.242 Logic II
Prereq: 24.241 or permission of instructor
U (Spring)
3-0-9 HASS
The central results of modern logic: the completeness of predicate logic, recursive functions, the incompleteness of arithmetic, the unprovability of consistency, the indefinability of truth, Skolem-Löwenheim theorems, and nonstandard models.
V. McGee

24.243 Classical Set Theory
Prereq: 24.241 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Introduction to the basic concepts and results of standard, i.e., Zermelo-Fraenkel, set theory, the axioms of ZF, ordinal and cardinal arithmetic, the structure of the set-theoretic universe, the axiom of choice, the (generalized) continuum hypothesis, inaccessibles, and beyond.
V. McGee

24.244 Modal Logic
Prereq: 24.241
U (Fall)
3-0-9 HASS
Sentential and quantified modal logic, with emphasis on the model theory ("possible worlds semantics"). Soundness, completeness, and characterization results for alternative systems. Tense and dynamic logics, epistemic logics, as well as logics of necessity and possibility. Applications in philosophy, theoretical computer science, and linguistics.
R. Stalnaker

24.251 Introduction to Philosophy of Language
Prereq: One philosophy subject
U (Spring)
3-0-9 HASS
Examination of views on the nature of meaning, reference, truth, and their relationships. Other topics may include relationships between language and logic, language and knowledge, language and reality, language and acts performed through its use. No knowledge of logic or linguistics presupposed.
S. Yablo

24.253 Philosophy of Mathematics
Prereq: One philosophy subject or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Philosophical issues about or related to mathematics, including the existence and nature of basic mathematical objects such as numbers and sets, how we can come to have knowledge of such objects, the status of mathematical truth, the relation of mathematics to logic, and whether classical logic can be called into question.
V. McGee

24.260 Topics in Philosophy
Prereq: Two subjects in philosophy
U (Spring)
3-0-9 HASS
Close examination of a single book, or group of related essays, with major significance in recent philosophy. Subject matter varies from year to year. Intended primarily for majors and minors in philosophy. Opportunities are provided for oral presentation. Students will be required to revise at least one paper in response to instructor's comments.
C. Hare

24.263 The Nature of Creativity
(Subject meets with CMS.810)
Prereq: None
U (Spring)
3-0-9 HASS
Introduction to the nature of creativity as it pervades human experience and behavior. Questions about imagination and innovation studied in relation to the history of philosophy as well as more recent work in philosophy, affective psychology, cognitive studies, and art theory. Readings and guidance with student's focus of interest. Instruction and practice in oral and written communication provided.
I. Singer

24.280 Foundations of Probability
Prereq: One philosophy subject or one subject on probability
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Topics include probability puzzles, common fallacies in probabilistic reasoning, defenses and criticisms of Kolmogorov's axiomatization, interpretations of probability (including the frequency, logical, propensity, and various subjectivist interpretations), the relation of objective chance to rational subjective credence, conditional probability, rules for updating probability, and proposals for supplementing the probability calculus with further principles.
V. McGee

24.292 Special Topics in Philosophy
Prereq: Any two subjects in philosophy
U (Fall)
Units arranged
Open to qualified students who wish to pursue special studies or projects. Students electing this subject must consult the department head.
Staff
24.293 Special Topics in Philosophy
Prereq: Any two subjects in philosophy
U (Spring)
Units arranged
Open to qualified students who wish to pursue special studies or projects. Students electing this subject must consult the department head.
Staff

24.400 Proseminar in Philosophy I
Prereq: Permission of instructor
G (Fall)
6-0-18 H-LEVEL Grad Credit
24.401 Proseminar in Philosophy II
Prereq: Permission of instructor
G (Spring)
6-0-18 H-LEVEL Grad Credit
Advanced study of the basic problems of philosophy. Intended for first-year graduate students in philosophy.
Fall: R. Langton, R. White
Spring: R. Holton, R. Stalnaker

24.410 Topics in the History of Philosophy
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor and advisor
Intensive study of a philosopher or philosophical movement. Content varies from year to year.
R. Langton

24.500 Topics in Philosophy of Mind
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Selected topics in philosophy of mind. Content varies from year to year. Topics may include consciousness, mental representation, perception, and mental causation.
A. Byrne

24.501 Problems in Metaphysics
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor and advisor
Systematic examination of selected problems in metaphysics. Content varies from year to year.
Fall: S. Yablo
Spring: G. Strawson

24.502 Topics in Metaphysics and Ethics
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor and advisor
Systematic examination of selected problems concerning the relation between metaphysics and ethics, for example questions about personal identity and its relation to issues about fairness and distribution, or questions about the relation between causation and responsibility. Content may vary from year to year.
C. Hare

24.601 Topics in Moral Philosophy
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Systematic examination of selected problems in moral philosophy. Content varies from year to year.
C. Hare

24.611J Political Philosophy
(Same subject as 17.000J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 17.000J.
S. Haslanger, R. Langton

24.711 Topics in Philosophical Logic
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor and advisor
Problems of ontology, epistemology, and philosophy of language that bear directly on questions about the nature of logic and the conceptual analysis of logical theory, such as logical truth, logical consequence, and proof. Content varies from year to year.
V. McGee

24.729 Topics in Philosophy of Language
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor
Major issues in the philosophy of language. Topics change each year.
A. Berger

24.801 Philosophy of Mathematics
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Examination of major philosophies of mathematics logicism, formalism, intuitionism on the nature of mathematical proof, existence of mathematical entities, and related issues. It is strongly recommended that students have taken 24.241 or equivalent.
S. Yablo

24.805 Topics in Theory of Knowledge
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor
Major issues in theory of knowledge. Topics change each year.
R. White

24.810 Topics in Philosophy of Science
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor and advisor
Topics in the foundations of science: the nature of concepts and theories, the distinction between empirical and theoretical knowledge claims, realist and instrumentalist interpretation of such claims, and the analysis of scientific explanation. The central topic varies from year to year.
B. Skow
linguistics and philosophy

24.911 Special Graduate Topics in Philosophy
Prereq: Permission of advisor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

24.921 Special Graduate Topics in Philosophy
Prereq: Permission of advisor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Open to qualified graduate students in philosophy who wish to pursue special studies or projects.
Consult Department Headquarters

24.899 Topics in Linguistics and Philosophy
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Selected topics at the intersection of linguistics and philosophy. Intended for graduate students in either linguistics or philosophy. Topics vary from year to year.
K. von Fintel

24.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

24.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Research opportunities in linguistics and philosophy. For further information consult the departmental coordinators.
Linguistics: E. Flemming
Philosophy: I. Singer

LINGUISTICS

24.900 Introduction to Linguistics
Prereq: None
U (Fall, Spring)
4-0-8 HASS-D, Category 2, CI-H
Studies what is language and what does knowledge of a language consist of. It asks how do children learn languages and is language unique to humans; why are there many languages; how do languages change; is any language or dialect superior to another; and how are speech and writing related. Context for these and similar questions provided by basic examination of internal organization of sentences, words, and sound systems. Assumes no prior training in linguistics.
Fall: D. Steriade
Spring: S. Flynn

24.901 Language and Its Structure I: Phonology
(Subject meets with 24.931)
Prereq: 24.900
U (Fall)
3-0-9 HASS
Introduction to fundamental concepts in phonological theory and their relation to issues in philosophy and cognitive psychology. Articulatory and acoustic phonetics, distinctive features and the structure of feature systems, underlying representations and underspecification, phonological rules and derivations, syllable structure, accentual systems, and the morphology-phonology interface. Examples and exercises from a variety of languages.
M. Kenstowicz

24.902 Language and Its Structure II: Syntax
(Subject meets with 24.932)
Prereq: 24.900
U (Fall)
3-0-9 HASS
Introduction to fundamental concepts in syntactic theory and its relation to issues in philosophy and cognitive psychology. Examples and exercises from a variety of languages.
M. DeGraff

24.903 Language and Its Structure III: Semantics and Pragmatics
(Subject meets with 24.933)
Prereq: 24.900
U (Spring)
3-0-9 HASS
M. Hackl

24.904J Language Acquisition
(Same subject as 9.57J)
Prereq: 24.900 or permission of instructor
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 HASS
See description under subject 9.57J.
K. Wexler

24.905J Psycholinguistics
(Same subject as 9.59J)
Prereq: 24.900 or permission of instructor or Coreq: 9.00
U (Spring)
3-0-9 HASS
See description under subject 9.59J.
E. Gibson

24.906J The Linguistic Study of Bilingualism
(Same subject as 21F.024J)
Prereq: 24.900
U (Fall)
3-0-9 HASS, CI-H
Development of bilingualism in human history (from Australopithecus to present day). Focuses on linguistic aspects of bilingualism; models of bilingualism and language acquisition; competence versus performance; effects of bilingualism on other domains of human cognition; brain imaging studies; early versus late bilingualism; opportunities to observe and conduct original research; and implications for educational policies among others. Taught in English. Enrollment limited.
S. Flynn

24.907J Abnormal Language
(Same subject as 9.56J)
Prereq: 24.900 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9
See description under subject 9.56J.
K. Wexler

24.908 Creole Languages and Caribbean Identities
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS, CI-H
Caribbean Creole languages result from language contact via colonization and the slave trade. Explores creolization from cognitive, historical and comparative perspectives and evaluates popular theories about “Creole genesis” and the role of language acquisition. Also explores non-linguistic creolization—in literature, religion and music in the Caribbean—and addresses issues of Caribbean identities by examining Creole speakers’ and others’ beliefs toward Creole cultures. Draws comparisons with aspects of African-American culture.
M. DeGraff
24.909 Field Methods in Linguistics (New)
Prereq: 24.901, 24.902, permission of instructor
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-1-8 Institute LAB
Explores the structure of an unfamiliar language through direct work with a native speaker. Students complete a grammatical sketch of the phonology and syntax, work in groups on specific aspects of the language's structure, and assemble reports to create a partial grammar of the language. Provides instruction and practice in written and oral communication. Enrollment limited.
S. Iatridou

24.910 Advanced Topics in Linguistic Analysis
Prereq: 24.901, 24.902, 24.903; or permission of instructor
U (Spring)
3-0-9 HASS
Can be repeated for credit
In-depth study of an advanced topic in phonetics, morphology, syntax or semantics, with a focus on the interfaces among these grammar components. Provides practice in written and oral communication.
Staff

24.912J Black Matters: Introduction to Black Studies
(Same subject as SP.417J, 21A.114J, 21H.106J, 21L.008J, 21M.630J, 21W.741J)
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 4, CI-H
See description under subject 21M.630J.
T. DeFrantz, S. Alexandre, C. Capozzola

24.914 Language Variation and Change (New)
Prereq: 24.900
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Explores how linguistic systems vary across time and space. Uses case studies in particular languages to examine how language transmission and social factors shape the grammatical systems of individual speakers, and how grammar constrains variation and change. Students work in groups to analyze corpus or survey data. Provides instruction and practice in written and oral communication.
Staff

24.915 Linguistic Phonetics (New)
(Subject meets with 24.963)
Prereq: 24.900
U (Spring)
3-0-9 HASS
The study of speech sounds: how we produce and perceive them and their acoustic properties. The influence of the production and perception systems on phonological patterns and sound change. Acoustic analysis and experimental techniques. Students taking the graduate version complete different assignments.
E. Flemming

24.918 Workshop in Linguistic Research (New)
Prereq: 24.901, 24.902, 24.903; or permission of instructor
U (Spring)
3-0-9 HASS
Students pursue individual research projects in linguistic analysis under the guidance of an advisor. Class meets weekly for presentation of student research and to critically discuss background reading. Focuses on developing skills in linguistic argumentation and presentation of findings. Provides practice in written and oral communication. Includes a 20-page final paper that each student presents to the class.
Staff

24.919 Special Undergraduate Topics in Linguistics
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Open to qualified students who wish to pursue special studies or projects.
Consult Department Headquarters

24.921 Special Graduate Topics in Linguistics
Prereq: Permission of advisor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Open to qualified graduate students in linguistics who wish to pursue special studies or projects.
Consult Department Headquarters

24.922 Special Graduate Topics in Linguistics
Prereq: Permission of advisor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Open to qualified graduate students in linguistics who wish to pursue special studies or projects.
Consult Department Headquarters

24.931 Language and Its Structure I: Phonology
(Subject meets with 24.901)
Prereq: 24.900 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Meets with 24.901, but assignments differ. See description under 24.901.
M. Kenstowicz

24.932 Language and Its Structure II: Syntax
(Subject meets with 24.902)
Prereq: 24.900 or permission of the instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Meets with 24.902, but assignments differ. See description under 24.902.
M. DeGraff

24.933 Language and Its Structure III: Semantics and Pragmatics
(Subject meets with 24.903)
Prereq: 24.900 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Meets with 24.903, but assignments differ. See description under 24.903.
M. Hackl

24.941J The Lexicon and Its Features
(Same subject as 6.543J, 9.587J, HST.727J)
Prereq: 24.901 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Overview of features that distinguish sound categories in languages of the world. Theories that relate these categories to their acoustic and articulatory correlates, both universally and in particular languages. Models of word recognition by listeners. A variety of perspectives on these issues, drawn from electrical engineering and computer science, linguistics and cognitive science.
D. Gow, D. Steriade, S. Shattuck-Hufnagel
24.942 Topics in the Grammar of a Less Familiar Language
Prereq: 24.951
G (Spring)
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit

Students work with a native speaker of a language whose structure is significantly different from English, examining aspects of its syntax, semantics, and phonology. In the course of doing this, students will acquire techniques for gathering linguistic data from native speakers. Enrollment limited.

M. Kenstowicz, N. Richards

24.943 Syntax of a Language (Family) (New)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit

Detailed examination of the syntax of a particular language or language family, and theories proposed in the existing literature to account for the observed phenomena.

Staff

24.945] Language Processing
(Same subject as 9.591J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

See description under subject 9.591J.

E. Gibson

24.946 Linguistic Theory and Japanese Language
(Subject meets with 21F.514)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-6

Detailed examination of the grammar of Japanese and its structure which is significantly different from English, with special emphasis on problems of interest in the study of linguistic universals. Data from a broad group of languages studied for comparison with Japanese. Meets with undergraduate subject 21F.514, but assignments differ. Assumes familiarity with linguistic theory.

S. Miyagawa

24.947 Language Disorders in Children
Prereq: None
G (Fall)
3-0-9

Reading and discussion of current linguistic theory, first language acquisition and language disorders in young children. Focus on development of a principled understanding of language disorders at the phonological, morphological and syntactic levels. Examines ways in which these disorders confront theories of language and acquisition.

S. Flynn

24.948 Linguistic Theory and Second Language Acquisition
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-6

Reading and discussion of current linguistic theory, first language acquisition research, and data concerning adult second language acquisition. Focus on development of a theory of second language acquisition within a theory of universal grammar. Emphasis on syntactic, lexical, and phonological development. Examination of ways in which this body of data confronts theories of language.

S. Flynn

24.949J Language Acquisition I
(Same subject as 9.601J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

See description under subject 9.601J.

K. Wexler

24.951 Introduction to Syntax
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Introduction to theories of syntax underlying work currently being done within the lexical-functional and government-binding frameworks. Organized into three interrelated parts, each focused upon a particular area of concern: phrase structure; the lexicon; and principles and parameters. Grammatical rules and processes constitute a focus of attention throughout the course that serve to reveal both modular structure of grammar and interaction of grammatical components.

N. Richards

24.952 Advanced Syntax
Prereq: 24.951
G (Spring)
3-0-9 H-LEVEL Grad Credit

Problems in constructing an explanatory theory of grammatical representation. Topics drawn from current work on anaphora, casemarking, control, argument structure, Wh- and related constructions. Study of language-particular parameters in the formulation of linguistic universals.

M. DeGraff, D. Pesetsky

24.954 Pragmatics in Linguistic Theory
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Formal theories of context-dependency, presupposition, implicature, context-change, focus and topic. Special emphasis on the division of labor between semantics and pragmatics. Applications to the analysis of quantification, definiteness, presupposition projection, conditionals and modality, anaphora, questions and answers.

D. Fox

24.955 More Advanced Syntax
Prereq: 24.951, 24.952
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

An advanced-level survey of topics in syntax.

Staff

24.956 Topics in Syntax
Prereq: 24.951
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

The nature of linguistic universals that make it possible for languages to differ and place limits on these differences. Study of selected problem areas show how data from particular languages contribute to the development of a strong theory of universal grammar and how such a theory dictates solutions to traditional problems in the syntax of particular languages.

Fall: D. Fox, S. Miyagawa, D. Pesetsky
Spring: N. Richards
24.959 Workshop in Syntax and Semantics
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
An intensive group tutorial/seminar for discussion of research being conducted by participants. No listeners allowed.
M. Hackl, N. Richards

24.960 Syntactic Models
Prereq: 24.951, 24.952
G (Spring)
3-0-9 H-LEVEL Grad Credit
Comparison of different proposed architectures for the syntax module of grammar. Subject traces several themes across a wide variety of approaches, with emphasis on testable differences among models. Models discussed include ancient and medieval proposals, structuralism, early generative grammar, generative semantics, government-binding theory/minimalism, LFG, HPSG, TAG, functionalist perspectives and others.
D. Steriade

24.961 Introduction to Phonology
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Introduction to the current research questions in phonological theory. Topics include metrical and prosodic structure, features and their phonetic basis in speech, acquisition and parsing, phonological domains, morphology, and language change and reconstruction. Activities include problem solving, squibs, and data collection.
E. Flemming

24.962 Advanced Phonology
Prereq: 24.961
G (Spring)
4-0-8 H-LEVEL Grad Credit
Continuation of 24.961.
D. Steriade

24.963 Linguistic Phonetics
(Same subject as 24.942 to 24.981)
Prereq: None
G (Spring)
3-0-9
See description under subject 24.915.
E. Flemming

24.964 Topics in Phonology
Prereq: 24.961
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
In-depth study of a topic in current phonological theory.
A. Albright

24.965 Morphology
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
A. Albright, D. Pesetsky

24.966J Laboratory on the Physiology, Acoustics, and Perception of Speech
(Same subject as 6.542, HST.712J)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
2-2-8 H-LEVEL Grad Credit
See description under subject 6.542.
L. D. Braida, S. Shattuck-Hufnagel

24.967 Topics in Experimental Phonology
Prereq: 24.961, 24.963, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Experimental techniques to test predictions drawn from current phonological theory. Includes a survey of experimental methodologies currently in use, an introduction to experimental design and analysis, and critical consideration of how experimental results are used to inform theory.
A. Albright, E. Flemming

24.968J Speech Communication
(Same subject as 6.541J, HST.710J)
Prereq: Permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit
See description under subject 6.541.
L. D. Braida, R. E. Hillman, S. Shattuck-Hufnagel

24.969 Workshop in Phonology and Morphology
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
An intensive group tutorial/seminar for discussion of research being conducted by participants. No auditors are allowed.
A. Albright, M. Kenstowicz

24.970 Introduction to Semantics
Prereq: Permission of instructor
G (Fall)
3-0-9
Basic issues of form and meaning in formalized and natural languages. Conceptual, logical, and linguistic questions about truth. Reference, modal, and intensional notions. The role of grammar in language use and context-dependency. Ambiguities of structure and meaning, and dimensions of semantic variation in syntax and the lexicon.
I. Heim

24.973 Advanced Semantics
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Current work on semantics and questions of logic and meaning for syntactic systems in generative grammar.
K. von Fintel

24.979 Topics in Semantics
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Seminar on current research in semantics and generative grammar. Topics may vary from year to year.
Fall: K. von Fintel, S. Iatridou
Spring: D. Fox, M. Hackl

24.981 Topics in Computational Phonology
Prereq: 24.961 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Exploration of issues in the computational modeling of phonology: finding generalizations in data, formalisms for representing phonological knowledge, modeling grammar acquisition, and testing phonological theories by means of implemented models. Experience using and developing models, including preparing training data, running simulations, and interpreting
their results. No background in programming or machine learning is assumed.

A. Albright

**24.992 Survey of General Linguistics**
Prereq: Permission of instructor
G (Fall)
3-0-9
Can be repeated for credit

Reading and discussion of certain important papers in syntax, semantics, and phonology designed to familiarize the student with central ideas in current linguistic research. Organization of discussion is primarily in the hands of seminar participants.

*E. Flemming, I. Heim, N. Richards*

**24.993 Tutorial in Linguistics and Related Fields**
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Individual or small-group tutorial in which students, under the guidance of a faculty member, explore the interrelations with linguistics of some specified area.

*Consult Department Headquarters*

**24.ThG Graduate Thesis**
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Program of research and writing of thesis, to be arranged by the student with supervising committee.

*Staff*

**24.UR Undergraduate Research**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

**24.URG Undergraduate Research**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Research opportunities in linguistics and philosophy. For further information consult the departmental coordinators.

*Linguistics: E. Flemming*

*Philosophy: I. Singer*
# Bachelor of Science in Philosophy/Course 24-1

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>[three subjects can be satisfied by subjects in the Departmental Program for the field of concentration]</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**: 17

## Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

## PLUS Departmental Program

Subject names below are followed by credit units and by prerequisites, if any (corequisites in italics).

### Required Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>One HASS-D philosophy subject</td>
<td>72</td>
</tr>
<tr>
<td>One History of Philosophy subject:</td>
<td></td>
</tr>
<tr>
<td>24.01 Classics in Western Philosophy, 12, HASS-D, CI-H</td>
<td></td>
</tr>
<tr>
<td>24.201 Topics in the History of Philosophy, 12, HASS, CI-M *</td>
<td></td>
</tr>
<tr>
<td>One Knowledge and Reality subject:</td>
<td></td>
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<tr>
<td>24.09 Minds and Machines, 12, HASS-D, CI-H</td>
<td></td>
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<tr>
<td>24.111 Philosophy of Quantum Mechanics, 12, HASS</td>
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<tr>
<td>24.112 Space, Time, and Relativity, 12, HASS</td>
<td></td>
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<tr>
<td>24.114 A Philosophical History of Energy, 12, HASS</td>
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<tr>
<td>24.211 Theory of Knowledge, 12, HASS *</td>
<td></td>
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<tr>
<td>24.215 Topics in the Philosophy of Science, 12, HASS *</td>
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<tr>
<td>24.221 Metaphysics, 12, HASS, CI-M *</td>
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<tr>
<td>24.251 Introduction to Philosophy of Language, 12, HASS *</td>
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<tr>
<td>24.253 Philosophy of Mathematics, 12, HASS *</td>
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<tr>
<td>24.280 Foundations of Probability, 12, HASS *</td>
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<tr>
<td>One Value subject:</td>
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<tr>
<td>24.02 Moral Problems and the Good Life, 12, HASS-D, CI-H</td>
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<td>24.04 Justice, 12, HASS-D, CI-H</td>
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<tr>
<td>24.06 Bioethics, 12, HASS-D, CI-H</td>
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<tr>
<td>24.120 Moral Psychology, 12, HASS, CI-M</td>
<td></td>
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<tr>
<td>24.209 Philosophy in Film and Other Media, 12, HASS</td>
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<tr>
<td>24.213 Philosophy of Film, 12, HASS</td>
<td></td>
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<tr>
<td>24.214 Introduction to Philosophy of the Arts, 12, HASS</td>
<td></td>
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<tr>
<td>24.222 Decisions, Games and Rational Choice, 12, HASS</td>
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<tr>
<td>24.231 Ethics, 12, HASS, CI-M *</td>
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<tr>
<td>24.235 Philosophy of Law, 12, HASS *</td>
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<td>24.237 Feminist Theory, 12, HASS, CI-M *</td>
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<tr>
<td>24.253 The Nature of Creativity, 12, HASS, CI-M *</td>
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<tr>
<td>One Logic subject:</td>
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<tr>
<td>24.218 Paradox and Infinity, 12, HASS</td>
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<tr>
<td>24.241 Logic I, 12, HASS</td>
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<tr>
<td>24.242 Logic II, 12, HASS *</td>
<td></td>
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<tr>
<td>24.243 Classical Set Theory, 12, HASS *</td>
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<tr>
<td>24.244 Modal Logic, 12, HASS *</td>
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<tr>
<td>and 24.260 Topics in Philosophy, 12, HASS, CI-M *</td>
<td></td>
</tr>
</tbody>
</table>

### Restricted Electives

A coherent program of five additional subjects, of which two must be in philosophy.

To satisfy the requirement that students take two CI-M subjects, students must take 24.260 and one of the following: 24.120, 24.201, 24.221, 24.231, 24.237, or 24.263.

### Departmental Program Units That Also Satisfy the GIRs

(36)

### Unrestricted Electives

84–99

### Total Units Beyond the GIRs Required for SB Degree

180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

### Notes

* Prerequisites and corequisites are listed in the subject description.

** 24 No more than four of the total number of philosophy subjects for the major may be HASS-D philosophy subjects. At least three of the total number of philosophy courses must be at the 200 level or above.

** 25 May not also satisfy the departmental distribution requirement in philosophy.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
Bachelor of Science in Linguistics and Philosophy/Course 24-2

General Institute Requirements (GIRs)  
<table>
<thead>
<tr>
<th>Subjects</th>
<th>Science Requirement</th>
<th>Humanities, Arts, and Social Sciences Requirement [three subjects can be satisfied by subjects in the Departmental Program (for the field of concentration)]</th>
<th>Restricted Electives in Science and Technology (REST) Requirement</th>
<th>Laboratory Requirement</th>
<th>Total GIR Subjects Required for SB Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

Communication Requirement  
The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program  
Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

Required Subjects  

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
</table>
| 12 | Introduction to Linguistics, 12, HASS-D, CI-H  

Students choose either a linguistics or philosophy track

Linguistics Track  

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
</table>
| 84 | Language and Its Structure I: Phonology, 12, HASS *  
| 12 | Language and Its Structure II: Syntax, 12, HASS, CI-M *  
| 12 | Language and Its Structure III: Semantics and Pragmatics, 12, HASS *  
| 12 | Workshop in Linguistic Research, 12, HASS, CI-M *  
| 12 | One of the following three Linguistic Analysis subjects:  
| 12 | Field Methods in Linguistics, 12, LAB, CI-M *  
| 12 | Advanced Topics in Linguistic Analysis, 12, HASS, CI-M *  
| 12 | Language Variation and Change, 12, HASS-D, CI-M *  
| 12 | One of the following three Philosophy subjects:  
| 12 | Minds and Machines, 12, HASS-D, CI-H  
| 12 | Logic I, 12, HASS  
| 12 | Introduction to Philosophy of Language, 12, HASS *  
| 12 | One of the following five Experimental Results subjects:  
| 12 | Language Acquisition, 12, HASS *  
| 12 | Psycholinguistics, 12, HASS *  
| 12 | The Linguistic Study of Bilingualism, 12, HASS, CI-H *  
| 12 | Abnormal Language, 12, HASS *  
| 12 | Linguistic Phonetics, 12, HASS *  

Philosophy Track  

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
</table>
| 84 | Minds and Machines, 12, HASS-D, CI-H  
| 12 | Topics in the History of Philosophy, 12, HASS, CI-M *  
| 12 | Logic I, 12, HASS  
| 12 | Introduction to the Philosophy of Language, 12, HASS *  
| 12 | Topics in Philosophy, 12, HASS, CI-M *  
| 12 | One of the following Knowledge and Reality subjects:  
| 12 | Philosophy of Quantum Mechanics, 12, HASS  
| 12 | Space, Time, and Relativity, 12, HASS  
| 12 | A Philosophical History of Energy, 12, HASS  
| 12 | Theory of Knowledge, 12, HASS *  
| 12 | Topics in the Philosophy of Science, 12, HASS *  
| 12 | Metaphysics, 12, HASS, CI-M *  
| 12 | Philosophy of Mathematics, 12, HASS *  
| 12 | Foundations of Probability, 12, HASS *  
| 12 | One of the following three subjects:  
| 12 | Cognitive Processes, 12, HASS *  
| 12 | Language Acquisition, 12, HASS *  
| 12 | Psycholinguistics, 12, HASS *  

Restricted Electives  
A coherent program of three additional subjects from linguistics, philosophy, or a related area.

Departmental Program Units That Also Satisfy the GIRs  

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
</tr>
</tbody>
</table>

Unrestricted Electives  

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>84–93</td>
</tr>
</tbody>
</table>

Total Units Beyond the GIRs Required for SB Degree  
No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes  
*Prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help in the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
UNDERGRADUATE SUBJECTS

CMS.100 Introduction to Media Studies
Prereq: None
U (Fall)
3-3-6 HASS, Category 4, CI-H
Offers an overview of the social, cultural, political, and economic impact of mediated communication on modern culture. Combines critical discussions with experiments working with different media. Media covered include radio, television, film, the printed word, and digital technologies. Topics include the nature and function of media, core media institutions, and media in transition.
M. Marks

CMS.300 Introduction to Videogame Studies
(Subject meets with CMS.841)
Prereq: None
U (Fall)
3-3-6 HASS
Introduction to the interdisciplinary study of commercial videogames as texts through an examination of their cultural, educational, and social functions in contemporary settings. Students play and analyze videogames while reading current research and theory from a variety of sources in the sciences, social sciences, humanities, and industry. The expectation is that students will play through to completion a contemporary commercial videogame chosen in consultation with the instructor. Regular reading, writing, and presentation exercises; open to students from all disciplines and levels of experience. Students taking the graduate version complete additional assignments.
D. Rusch

CMS.309J Transmedia Storytelling: Modern Science Fiction
(Same subject as 21W.763J)
(Subject meets with CMS.809)
Prereq: None
U (Fall)
3-0-9 HASS
See description under subject 21W.763J.
B. Coleman

CMS.336J The Social Documentary: Analysis and Production
(Same subject as 21W.786J)
(Subject meets with CMS.836)
Prereq: None
U (Fall)
3-0-9 HASS
See description under subject 21W.786J.
V. Bald

CMS.376 History of Media and Technology
(Subject meets with CMS.876)
Prereq: Permission of instructor
U (Fall)
3-3-6 HASS
Mutually influential histories of communications media and technological development, focusing on the shift from analog to digital cultures that began mid-century and continues to the present. Theoretical and philosophical works, canonical and minority histories, literature and art, as well as production issues leading toward the advancement of student projects and research papers. Each topic in the series reflects a particular theme in the history of media and technology. Students taking the graduate version complete additional assignments.
B. Coleman, J. Paradis

CMS.400 Media Systems and Texts
Prereq: One subject in CMS or permission of instructor
U (Spring)
3-3-6 HASS
Explores theoretical, historical and critical approaches to the comparative study of media. Examines media from three perspectives: the historical evolution of particular media forms (media in transition); the migration of particular narratives across different media forms (transmedia texts); and the ways in which media texts and systems cross cultural and national boundaries (global crossings).
Staff

CMS.403J Media and Methods: Performing
(Subject as 21M.703J)
Prereq: CMS.100, 21L.011, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-3-6 HASS
Seminar examines an array of performance disciplines from the perspective of the performer. Explores what it means to read the human body as a dynamic medium of expression; how fundamental techniques of the performer shift across cultural borders and in step with changing social contexts and historical traditions; and how the expressive tactics of one media platform adapt to the demands of another. Students engage in close analysis of performance practices, acquiring a theoretical and historical framework for thinking about performance across disciplines. Complemented by outside readings, video viewings, short essays, and studio performances, this course is intended to provide students with an introduction to core concepts in performance studies as they relate more generally to the study of media. Instruction and practice in written and oral communication provided. Enrollment limited to 20.
J. Scheib

CMS.405 Media and Methods: Seeing and Expression
Prereq: 21L.011 or CMS.100
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-3-6 HASS
Examines the process of making and sharing visual artifacts using a trans-cultural, trans-historical, constructionist approach. Explores the relationship between perceived reality and the narrative imagination, how an author’s choice of medium and method constrains the work, how desire is integrated into the structure of a work, and how the cultural/economic opportunity for exhibition/distribution affects the realization of a work. Students submit three papers and three visual projects. Final projects are displayed and critiqued in an exhibition at the end of term. Instruction and practice in written and oral communication provided. Enrollment limited to 20.
G. Davenport
CMS.407 Media and Methods: Sound (New)
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 HASS
Credit cannot also be received for 21A.360
Explores the ways in which humans experience the realm of sound and how perceptions and technologies of sound emerge from cultural, economic, and historical worlds. Examines how environmental, linguistic, and musical sounds are construed cross-culturally. Describes the rise of telephony, architectural acoustics, and sound recording, and the globalization of these technologies. Addresses questions of ownership, property, authorship, and copyright in the age of digital file sharing. Particular focus on how the sound/noise boundary is imagined, created and modeled across diverse sociocultural and scientific contexts. Auditory examples—sound art, environmental recordings, music—will be provided and invited. Instruction and practice in written and oral communication provided. Meets with 21A.360 during fall 2009. Limited to 20.
S. Helmreich

CMS.590] Computer Games and Simulations for Investigation and Education
(Same subject as 11.127J)
(Subject meets with 11.252J, CMS.863J)
Prereq: None
U (Spring)
3-6-3
See description under subject 11.127J.
E. Klopfer

CMS.600 Topics in Comparative Media Studies
Prereq: Permission of instructor
U (Spring)
Units arranged
Can be repeated for credit
Open to qualified students who wish to pursue special projects with members of the CMS faculty.
Staff

CMS.601 Topics in Comparative Media Studies
Prereq: None
U (Spring)
Units arranged
Can be repeated for credit
Open to qualified students who wish to pursue special projects with members of the CMS faculty. Usually limited to 12 units of credit.
Staff

CMS.602 Topics in Comparative Media Studies
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit
Discussion of current interest special topics not otherwise included in the curriculum.
Fall: S. Osterweil
Spring: Staff

CMS.603 Topics in Comparative Media Studies
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Staff

CMS.604 Topics in Comparative Media Studies
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Staff

CMS.607 The Role of the Gamer: Theory, Criticism, and Practice
(Subject meets with CMS.843)
Prereq: One introductory CMS subject or permission of instructor
U (Spring)
3-0-9 HASS
Overview of scholarship in the emerging field of game studies examines gamers and their relationships with digital content as well as with other gamers in virtual and online spaces. Draws on current commercial practices in relation to underlying humanistic and social scientific theory and criticism to better understand player-game interactions, processes of identity formation, and participation in online communities. Historically situated analytic perspectives include effects, uses and gratifications, reader-response, and reception theories. Examines case studies of new computer interface design methodologies, usability testing, market research, and production issues related to contemporary game design and platforms. Students taking the graduate version complete additional assignments. Enrollment limited to 30.
Staff

CMS.608 Game Design
(Subject meets with CMS.864)
Prereq: One subject in CMS or permission of instructor
U (Fall)
3-3-6 HASS
An historical examination and analysis of the evolution and development of games and game mechanics. Topics include a large breadth of genres and types of games, including sports, game shows, games of chance, schoolyard games, board games, roleplaying games, and digital games. Students submit essays documenting research and analysis of a variety of traditional and eclectic games. Project teams required to design, develop, and thoroughly test their original games. Enrollment limited to 20.
P. Tan

CMS.609J The Word Made Digital
(Same subject as 21W.764J)
(Subject meets with CMS.846)
Prereq: None
U (Fall)
3-0-9 HASS
See description under subject 21W.764J.
N. Montfort

CMS.610 Media Industries and Systems
(Subject meets with CMS.922)
Prereq: Two CMS subjects or permission of instructor
U (Spring)
3-0-9 HASS
Can be repeated for credit
Introduces the Creative Industries as a paradigm to understand developments in the media and content industries. Studies the significance of creativity and creative entrepreneurship, positioning the creative industries as key sectors of the knowledge economy. Considers the importance for the media and content industries of technological convergence, intellectual property laws, globalization and the rise of the creative class.
C. Weaver

CMS.THT Comparative Media Studies Pre-Thesis Tutorial
Prereq: Permission of advisor
U (Fall, Spring)
1-0-5
Student works with an advisor to define his/her thesis. By the end of the term, student must have a substantial outline and bibliography for thesis and must have selected a three-person
thesis committee. Advisor must approve outline and bibliography.

Staff

CMS.THU Undergraduate Thesis in Comparative Media Studies
Prereq: CMS.ThT
U (Fall, Spring)
Units arranged
Can be repeated for credit

The CMS Undergraduate Thesis is a substantial research project or comparable exercise. A written thesis ranges in length from 35 to 50 pages. Digital projects are assessed on the quality of research and argumentation, as well as presentation, and must include a substantial written component. Student gives an oral presentation of his/her thesis at the end of the term. Thesis is not required for CMS majors.

Staff

CMS.UR Research in Comparative Media Studies
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

CMS.URG Research in Comparative Media Studies
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.

Staff

GRADUATE SUBJECTS

CMS.790 Media Theories and Methods I
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-3-6 H-LEVEL Grad Credit

An advanced introduction to core theoretical and methodological issues in comparative media studies. Topics covered typically include the nature of theory, the gathering and evaluation of evidence, the relationship of media to reality, formal approaches to media analysis, the ethnographic documentation of media audiences, cultural hierarchy and taste, modes of production, models of readership and spectatorship.

W. Uricchio

CMS.791 Media Theories and Methods II
Prereq: CMS.790
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-3-6 H-LEVEL Grad Credit

An advanced introduction to core theoretical and methodological issues in comparative media studies. Topics covered typically include globalizaton, propaganda and persuasion, social and political effects of media change, political economy and the institutional analysis of media ownership, online communities, privacy and intellectual property, and the role of news and information within democratic cultures.

Staff

CMS.796 Major Media Texts
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-3-6 H-LEVEL Grad Credit

Intensive close study and analysis of historically significant media “texts” that have been considered landmarks or have sustained extensive critical and scholarly discussion. Such texts may include oral epic, story cycles, plays, novels, films, opera, television drama and digital works. Emphasizes close reading from a variety of contextual and aesthetic perspectives. Syllabus varies each year, and may be organized around works that have launched new modes and genres, works that reflect upon their own media practices, or on stories that migrate from one medium to another. At least one of the assigned texts is collaboratively taught, and visiting lectures and discussions are a regular feature of the subject.

D. Thorburn

CMS.801 Media in Transition
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Centers on historical eras in which the form and function of media technologies were radically transformed. Includes consideration of the “Gutenberg Revolution,” the rise of modern mass media, and the “digital revolution,” among other case studies of media transformation and cultural change. Readings in cultural and social history and historiographic method.

W. Uricchio

CMS.809 Transmedia Storytelling: Modern Science Fiction
(Subject meets with 21W.763J, CMS.309J)
Prereq: None
G (Fall)
3-0-9

See description under subject 21W.763J. Students taking the graduate version complete additional assignments.

B. Coleman

CMS.810 The Nature of Creativity
(Subject meets with 24.263)
Prereq: None
G (Spring)
3-0-9

Introduction to problems about creativity as it pervades human experience and behavior. Questions about imagination and innovation studied in relation to the history of philosophy as well as more recent work in philosophy, affective psychology, cognitive studies, and art theory. Readings and guidance with student’s focus of interest.

I. Singer

CMS.811 Introduction to Philosophy of the Arts
(Subject meets with 24.214)
Prereq: None
G (Fall)
3-0-9

Interdisciplinary introduction to principles of aesthetics in arts such as literature, film, music, and the media arts. Topics include the nature of imagination and creativity, and the role of art and aesthetics in science, ethics, and religion. Relevant screenings as well as readings. Students taking the graduate version will complete additional assignments.

I. Singer

CMS.820 Philosophy of Film
(Subject meets with 24.213)
Prereq: None
G (Spring)
3-0-9

Philosophical analysis of film art, with an emphasis on the ways in which it creates meaning through techniques that define a formal structure. Particular focus on aesthetic problems about appearance and reality, literary and visual effects, communication and alienation through film technology.

I. Singer
COMPARATIVE MEDIA STUDIES

CMS.830 Studies in Film
(Subject meets with 21L.706)
Prereq: Permission of instructor
G (Spring)
3-3-6
Can be repeated for credit
Meets with 21L.706, but assignments differ. See description under 21L.706.
P. Donaldson

CMS.835 Photography and Truth
(Subject meets with 21A.348)
Prereq: Permission of instructor
G (Spring)
3-0-9
Meets with 21A.348, but assignments differ. See description under subject 21A.348.
J. Howe

CMS.836 The Social Documentary: Analysis and Production
(Subject meets with 21W.786J, CMS.336J)
Prereq: None
G (Fall)
3-0-9
An introduction to the history of the social documentary from the 1960s through the 1980s. Explores how social upheaval and the shift to smaller, more portable film cameras, and ultimately hand-held video, converged to bring about an upsurge of socially engaged documentary film production. Students screen and analyze a series of key films from the period and work in groups to produce their own short documentary using digital video and computer-based editing. Enrollment limited to 18.
V. Bold

CMS.837 Film, Music, and Social Change: Intersections of Media and Society
(Subject meets with 21W.787)
Prereq: None
G (Spring)
3-0-9
Examines films from the 1950s onward that document music subcultures and moments of social upheaval. Combines screening films about free jazz, glam rock, punk, reggae, hip-hop, and other genres with an examination of critical/scholarly writings to illuminate the connections between film, popular music, and processes of social change. Students critique each film in terms of the social, political, and cultural worlds in which they operate. Students take the graduate version complete additional assignments. Enrollment limited to 18.
V. Bold

CMS.840 Literature and Film
(Subject meets with 21L.435)
Prereq: Permission of instructor
G (Fall, Spring)
3-3-6
Can be repeated for credit
Meets with 21L.435, but assignments differ. See description under subject 21L.435.
Fall: P. Donaldson
Spring: Staff

CMS.841 Introduction to Videogame Studies
(Subject meets with CMS.300)
Prereq: None
G (Fall)
3-3-6
See description under subject CMS.300.
D. Rusch

CMS.843 The Role of the Gamer: Theory, Criticism, and Practice
(Subject meets with CMS.607)
Prereq: One introductory CMS subject or permission of instructor
G (Spring)
3-0-9
Overview of emerging game studies scholarship, examining gamers and their relationships with digital content as well as with other gamers in virtual and online spaces. Draws upon industrial best practices as well as underlying humanistic and social scientific theory and criticism for understanding player-game interactions and processes of identity formation and participation in online communities. Historically situated analytic perspectives will include effects, uses and gratifications, reader-response, and reception theories. Examines case studies in a variety of topics including new methodologies in computer interface design, usability testing, and market research, development and production issues related to contemporary game design and platforms. Students taking the graduate version (CMS.843) complete additional assignments. Enrollment limited to 30.
Staff

CMS.845 Interactive and Non-Linear Narrative: Theory and Practice
(Subject meets with 21L.489J, 21W.765J)
Prereq: Permission of instructor
G (Fall)
3-0-9
Meets with 21L.489J/21W.765J, but assignments differ. See description under subject CMS.608.
N. Montfort

CMS.846 The Word Made Digital
(Subject meets with 21W.764J, CMS.609J)
Prereq: None
G (Fall)
3-0-9
Considers the many uses of text, language, and writing in creative digital media. Focuses on non-narrative uses of text, such as in information display, visual and lyrical settings, and human-legible computer code. Considers the use of text within the context of computing and different computing platforms. Draws on concepts and approaches from poetics, the material history of texts, and computer science. Assignments include individual and group writing projects, which involve reading and modifying computer programs. Previous programming experience and writing coursework helpful. Students taking the graduate version of this subject (CMS.846) complete additional assignments. Enrollment limited to 18.
N. Montfort

CMS.863J Computer Games and Simulations for Investigation and Education
(Same subject as 11.252J)
(Subject meets with 11.127J, CMS.590)
Prereq: None
G (Spring)
3-6-3
See description under subject 11.252J.
E. Klopfer

CMS.864 Game Design
(Subject meets with CMS.608)
Prereq: One subject in Comparative Media Studies or permission of instructor
G (Fall)
3-3-6
See description under subject CMS.608. Students taking the graduate version complete additional assignments. Enrollment limited to 20.
P. Tan

CMS.871 Media in Cultural Context
(Subject meets with SPA.493, 21L.715)
Prereq: Permission of instructor
G (Fall, Spring)
3-3-6
Can be repeated for credit
Seminar designed to provide close case study examinations of specific media or media configurations and the larger social, cultural, economic, political, or technological contexts within which they operate. Subject organized around recurring themes in media history, specific genres or movements, specific media, or specific historical moments. Instruction and practice in
written and oral communication provided. Previously taught topics include Gendered Genres: Horror and Maternal Melodramas, Comics, Cartoons, and Graphic Storytelling, and Exploring Children’s Culture. Meets with 21L.715, but assignments differ. Limited to 12.

Fall: Staff
Spring: J. Picker

CMS.874 Visualizing Cultures
(Subject meets with 21F.027, 21F.590, 21H.917)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9
See description under subject 21F.027.
S. Miyagawa, J. Dower

CMS.876 History of Media and Technology
(Subject meets with CMS.376)
Prereq: Permission of instructor
G (Fall)
3-3-6
Can be repeated for credit
See description under subject CMS.376.
B. Coleman, J. Paradis

CMS.880 From Print to Digital: Technologies of the Word: 1450–Present
(Subject meets with 21H.418)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9
Meets with 21H.418, but assignments differ.
Staff

CMS.882J Film, Fiction, and History in India, 1905–2005
(Same subject as 21H.577j)
Prereq: None
U (Spring)
2-0-10 HASS
See description under subject 21H.577j.
H. Roy

CMS.888 Advertising and Popular Culture: East Asian Perspectives
(Subject meets with 21F.036, 21F.190)
Prereq: Permission of instructor
G (Fall)
3-0-9
Meets with 21F.036 but assignments differ. See description under subject 21F.036.
J. Wang

CMS.910 Literature and Technology
(Subject meets with 21L.708)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9
Can be repeated for credit
Meets with 21L.708 but assignments differ. See description under 21L.708.
Staff

CMS.915 Understanding Television
(Subject meets with 21L.432)
Prereq: Permission of instructor
G (Spring)
3-3-6
Can be repeated for credit
Meets with 21L.432 but assignments differ. See description under 21L.432.
W. Uricchio

CMS.917 Documenting Culture
(Subject meets with 21A.337)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9
Surveys how and why people seek to capture life on film. Examines the motives of documentary and ethnographic filmmakers, including curiosity about exotic peoples, concern with documentary as a form of science, and an interest in capturing the truth about cultural life. Students view documentaries about people in the US and abroad, studying the relationship between film images and “reality,” tensions between art and observation, and the ethical relationship between filmmakers and those they film. Students taking the graduate version complete additional assignments.
C. Walley

CMS.920 Popular Narrative
(Subject meets with SP.492, 21L.430)
Prereq: Permission of instructor
G (Spring)
3-3-6
Can be repeated for credit
Meets with 21L.430, but assignments differ. Can be taken for graduate credit when topic is approved for Comparative Media Studies. See description under 21L.430.
Staff

CMS.922 Media Industries and Systems
(Subject meets with CMS.610)
Prereq: Permission of instructor
G (Spring)
3-0-9
Examines the interplay of art, technology, and commerce shaping the production, marketing, distribution, and consumption of contemporary media content. Combines perspectives on media industries and systems with an awareness of the creative process, the audience, and trends shaping content. Guest speakers from the media industry. Projects encourage students to think through the challenges of producing media in an industry context. Meets with CMS.610 but assignments differ.
C. Weaver

CMS.925 Film Music
(Subject meets with 21M.284)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-3-6
Surveys styles and dramatic functions of music for silent films of the 1910s-20s, and music in sound films from the 1930s to the present. Close attention given to landmark scores by American and European composers, including Korngold, Steiner, Rozsa, Prokofiev, Copland, Herrmann, Rota, Morricone, and Williams. Subsidiary topics include new trends in contemporary film-scoring, pop scores, the impact of electronics, and specialized genres (e.g., animation). Students taking the graduate version complete different assignments. Some background in the study of film and/or music is expected.
M. Marks

CMS.935 Documentary Photography and Photojournalism: Still Images of a World in Motion
(Subject meets with 21W.749)
Prereq: Permission of instructor
G (Spring)
3-0-9
Meets with 21W.749, but assignments differ.
B. D. Colen

CMS.950 Workshop I
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
4-2-6 H-LEVEL Grad Credit
Provides an opportunity for direct project development experience and emphasizes intellectual growth as well as the acquisition of technical skills. Students attend regular meetings to
present and critique their work and discuss its implications.

N. Montfort

CMS.951 Workshop II
Prereq: CMS.950
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
4-2-6 H-LEVEL Grad Credit

A continuation of Workshop I. Provides an opportunity for direct project development experience and emphasizes intellectual growth as well as the acquisition of technical skills. Students attend regular meetings to present and critique their work and discuss its implications.

Staff

CMS.980 Master's Thesis
Prereq: Permission of advisor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Completion of a graduate thesis, to be arranged with a faculty member, who becomes the thesis supervisor. Required of all CMS students.

Staff

CMS.990 Colloquium in Comparative Media
Prereq: None
G (Fall, Spring)
2-0-1 [P/D/F]
Can be repeated for credit

Exposes students to the perspectives of scholars, activists, mediamakers, policymakers, and industry leaders on cutting edge issues in media. Registered CMS graduate students only.

Staff

CMS.992 Portfolio in Comparative Media
Prereq: CMS.950 or permission of Instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Students work individually with an advisor to produce a portfolio project which combines technical skills and a substantial intellectual component.

Staff

CMS.993 Teaching in Comparative Media
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

For qualified graduate students interested in teaching. Offers experience in classroom and/or tutorial teaching under the supervision of a Comparative Media Studies faculty member.

Staff

CMS.994 Topics in Comparative Media Studies
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.

Staff

CMS.995 Research in Comparative Media
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Opportunity for research in comparative media studies under the supervision of a member of the Program. Used for graduate independent study.

Staff

CMS.996 Topics in Comparative Media Studies
Prereq: None
G (Spring)
Units arranged
Can be repeated for credit

Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.

Staff

CMS.997 Topics in Comparative Media
Prereq: None
G (Spring)
Units arranged
Can be repeated for credit

Discussion of current interest special topics not otherwise included in the curriculum.

Staff

CMS.998 Topics in Comparative Media
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit

Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.

Fall: S. Osterweil
Spring: Staff

CMS.999 Topics in Comparative Media
Prereq: None
G (Spring)
Units arranged
Can be repeated for credit

Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.

Staff
### Bachelor of Science in Comparative Media Studies/Course CMS

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [four subjects may be satisfied by subjects in the Departmental Program]</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

#### Communication Requirement
The program includes a Communication Requirement of 4 subjects:
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H), and 2 subjects designated as Communication Intensive in the Major (CI-M).

<table>
<thead>
<tr>
<th>PLUS Departmental Program</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).</td>
<td></td>
</tr>
<tr>
<td><strong>Required Subjects</strong></td>
<td>48</td>
</tr>
<tr>
<td>Tier I</td>
<td></td>
</tr>
<tr>
<td>21L.011 The Film Experience, 12, HASS-D, CI-H</td>
<td></td>
</tr>
<tr>
<td>CMS.100 Introduction to Media Studies, 12, HASS-D, CI-H</td>
<td></td>
</tr>
<tr>
<td>Tier II (Mid-tier)</td>
<td></td>
</tr>
<tr>
<td>Choose one of the following:</td>
<td></td>
</tr>
<tr>
<td>CMS.400 Media Systems and Texts, 12, HASS, CI-M; one subject in CMS or permission of instructor</td>
<td>60-108</td>
</tr>
<tr>
<td>CMS.403 Media and Methods: Performing, 12, HASS, CI-M; 21L.011, CMS.100, or permission of instructor</td>
<td>60-108</td>
</tr>
<tr>
<td>CMS.405 Media and Methods: Seeing and Expression, 12, HASS, CI-M; 21L.011 or CMS.100</td>
<td>60-108</td>
</tr>
<tr>
<td>CMS.407 Media and Methods: Sound, 12, HASS, CI-M; 21L.011 or CMS.100</td>
<td>60-108</td>
</tr>
<tr>
<td>Tier III (Capstone)</td>
<td></td>
</tr>
<tr>
<td>Choose one of the following:</td>
<td></td>
</tr>
<tr>
<td>21L.706 Studies in Film, 12, HASS, CI-M; 21L.011 and one subject in CMS or Literature; or permission of instructor</td>
<td></td>
</tr>
<tr>
<td>21L.715 Media in Cultural Context, 12, HASS, CI-M; two subjects in CMS and/or Literature, or permission of instructor</td>
<td></td>
</tr>
</tbody>
</table>

| Restricted Electives       | 72     |
| Students choose six restricted electives. Qualified students may, with departmental approval, substitute a pre-thesis tutorial (CMS.ThT) and thesis (CMS.ThU) for one elective. |       |

| Departmental Program Units That Also Satisfy the GIRs | (48) |
| Unrestricted Electives |       |
| 60–108                |       |
| **Total Units Beyond the GIRs Required for SB Degree** | **180** |

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

<table>
<thead>
<tr>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing &amp; Schedule, <a href="http://student.mit.edu/catalog/index.cgi">http://student.mit.edu/catalog/index.cgi</a>.</td>
</tr>
</tbody>
</table>
CSB.100J Topics in Computational and Systems Biology
(Same subject as 7.89J)
Prereq: Permission of instructor
G (Fall)
2-0-10 H-LEVEL Grad Credit
Seminar based on research literature. Papers covered are selected to illustrate important problems and varied approaches in the field of computational and systems biology, and to provide students a framework from which to evaluate new developments. Preference to first-year CSB PhD students.
C. Burge

CSB.110 Research Rotations in Computational and Systems Biology
Prereq: Permission of instructor
G (Fall, Spring)
0-12-0 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Students carry out research rotations with MIT faculty members or principal investigators working in the field of computational and systems biology. Generally three one-month long rotations are pursued that together span theoretical and experimental approaches. Open only to CSB PhD students.
Staff

CSB.190 Research Problems in Computational and Systems Biology
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Directed research in the field of computational and systems biology. Open only to CSB PhD students.
Staff

CSB.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research leading to the writing of SM or PhD thesis; to be arranged by the student and the MIT faculty advisor.
Information: Faculty Advisor
UNDERGRADUATE

ESD.01 J Engineering System Design
(Same subject as 1.041J)
Prereq: 1.011 or permission of instructor
U (Spring)
3-1-8
See description under subject 1.041J.
J. Sussman

ESD.018 J Project Management
(Same subject as 1.401J)
(Subject meets with 1.040)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 1.401J.
F. Moavenzadeh

ESD.032 J Communicating About Technology: Colossal Failures in Engineering
(Same subject as 1.588J, 3.070J, 22.002J, 21W.781J)
Prereq: None
U (Spring)
3-0-9 HASS, CI-H
See description under subject 21W.781J.
T. Eagar, W. Haas, A. Kadak, P. Lagacé, O. Buyukozturk

ESD.035 J Engineering Design and Rapid Prototyping
(Same subject as 16.810J)
Prereq: 16.01, 16.02 or 2.001, 2.002 or permission of instructor
U (IAP)
2-4-0
See description under subject 16.810J.
O. de Weck

ESD.04 Frameworks and Models in Engineering Systems
Prereq: Calculus II (GIR)
U (Spring)
3-0-9
Introduction to quantitative models and qualitative frameworks for studying complex engineering systems. The art of abstracting a complex system into a model for purposes of analysis and design while dealing with complexity, emergent behavior, stochasticity, non-linearities and the requirements of many stakeholders with divergent objectives. Architectural system configuration. Semester-long class project deals with critical contemporary issues which require an integrative, interdisciplinary approach using the above models and frameworks.
J. Sussman

ESD.05 Engineering Leadership Lab (New)
Prereq: None
U (Fall, Spring)
0-2-1 [P/D/F]
Can be repeated for credit
Develops leadership skills through participation in the phases of product development. Focuses on the affective behavior, character and values often needed during these phases. Content throughout the term is frequently student-driven. Restricted to students in the Bernard M. Gordon-MIT Engineering Leadership Program.
Fall: S. Luperfey
Spring: L. McGonagle

ESD.051 Engineering Innovation and Design (New)
Prereq: Permission of instructor
U (Spring)
2-2-2
Project-based seminar develops skills to effectively conceive, evaluate, plan, organize, lead, and implement engineering design projects. Includes techniques to sharpen creative thinking and critical analysis of designs, as well as utilize iterative processes. Students innovate, implement, and communicate designs that are practical, successful, elegant, interactive, robust, and holistic. Focus on project scope, and balancing real-world constraints against the limitations of technology and human cognition. Willingness to learn a computer markup language recommended. Limited to 60; preference to juniors and seniors.
J. Schindall, B. Kotelly

ESD.053 J Environmental Risks for Common Disease
(Same subject as 1.081J, 20.104J)
Prereq: Biology (GIR), Chemistry (GIR)
U (Spring)
3-0-9
See description under subject 20.104J.
W. G. Thilly, R. McCunney

TECHNOLOGY AND POLICY

ESD.10 Introduction to Technology and Policy
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Frameworks and models for Technology and Policy students explore perspectives in the policy process—agenda setting, problem definition, framing the terms of debate, formulation and analysis of options, implementation and evaluation of policy outcomes using frameworks including economics and markets, law, and business and management. Methods include cost/benefit analysis, probabilistic risk assessment, and system dynamics. Exercises include developing skills to work on the interface between technology and societal issues; simulation exercises; case studies; and group projects that illustrate issues involving multiple stakeholders with different value structures, high levels of uncertainty, multiple levels of complexity; and value trade-offs that are characteristic of engineering systems. Emphasis on negotiation, team building and group dynamics, and management of multiple actors and leadership.
A. Weigel

ESD.103 J Science, Technology, and Public Policy
(Same subject as 17.310J, STS.482J)
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 17.310J.
K. Oye
ESD.123J Industrial Ecology
(Same subject as 1.814J, 3.560J)
Prereq: ESD.10 or 3.56
G (Spring)
3-0-6 H-LEVEL Grad Credit
Quantitative techniques for life cycle analysis of the impacts of materials extraction, processing use, and recycling; and economic analysis of materials processing, products, and markets. Student teams undertake a major case study of automobile manufacturing using the latest methods of analysis and computer-based models of materials process.
R. Kirchain, J. Clark, F. Field

ESD.126 Energy Systems and Economic Development
Prereq: ESD.10
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-6 H-LEVEL Grad Credit
A team-based policy research subject focused on evaluation of energy technologies and their implementation within developing countries. Focuses on one or more specific nations, carries out a resource assessment, and develops an energy strategy that is congruent with technical potential, cultural requirements, and environmental constraints.
R. D. Tabors

ESD.128J Global Climate Change: Economics, Science, and Policy
(Same subject as 12.848J, 15.023J)
(Subject meets with 12.348J, 15.026J)
Prereq: Calculus II (GIR); 5.60; 14.01 or 15.010; or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 15.023J.
H. D. Jacoby, R. G. Prinn

ESD.129J Space Policy Seminar
(Same subject as 16.891J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.891J.
A. L. Weigel

ESD.132J Law, Technology, and Public Policy
(Same subject as 15.655J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Examination of the relationship between law and technological change, and the ways in which law, economics, and technological change shape public policy. Areas addressed include how law can be used to influence and guide technological change; responses of the legal system to environmental, safety, social and ethical problems created by new or existing technology; how law and markets interact to limit or encourage technological development; and how law can affect the distribution of wealth and social justice. Topics covered include genetic engineering; telecommunications; industrial automation; the effect of health, safety, and environmental regulation on technological innovation; the impacts of intellectual property law on innovation and equity; pharmaceuticals; nanotechnology; cost/benefit analysis as a decision tool; public participation in governmental decisions affecting science and technology; and law and economics as competing paradigms to encourage sustainability.
N. A. Ashford, C. C. Caldart

ESD.136J Technology, Law, and the Working Environment
(Same subject as 10.805J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 10.805J.
N. A. Ashford, C. C. Caldart

ESD.137J Sustainability, Trade, and the Environment
(Same subject as 1.813J, 11.466J, 15.657J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
The Schumpeterian notion of technological innovation as “the engine of growth” is being challenged as the globalization of trade is increasingly seen as the driving force of industrial economies. With the establishment of the World Trade Organization implementing the GATT, NAFTA, and other trading regimes, serious questions have been raised concerning the effects of global trade on sustainability, which must be viewed broadly to include not only a healthy economic base, but also a sound environment, stable employment, adequate purchasing power, distributional equity, national self-reliance, and maintenance of cultural integrity. Subject explores the many dimensions of sustainability and the use of national, multinational, and international political and legal mechanisms to further sustainable development.
N. A. Ashford

ESD.138J Environmental Law, Policy, and Economics: Pollution Prevention and Control
(Same subject as 1.811J, 11.630J)
(Subject meets with 1.801J, 11.021J, 17.393J)
Prereq: Permission of instructor for undergraduates
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.811J.
N. A. Ashford, C. C. Caldart

ESD.139J Regulation of Chemicals, Radiation, and Biotechnology
(Same subject as 1.812J, 11.631J)
(Subject meets with 1.802J, 11.022J)
Prereq: Permission of instructor for undergraduates
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.812J.
N. A. Ashford, C. C. Caldart

ESD.140J Sustainability, Trade, and the Environment
(Same subject as 10.805J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 10.805J.
N. A. Ashford, C. C. Caldart

ESD.151J Chemicals in the Environment: Fate and Transport
(Same subject as 1.725J)
Prereq: Permission of instructor
G (Fall)
3-0-9
See description under subject 1.725J.
H. Hemond, P. Shanahan

ESD.163J Managing Nuclear Technology
(Same subject as 22.812J)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 22.812J.
R. K. Lester
ESD.166J Sustainable Energy
(Same subject as 1.818J, 2.65J, 10.391J, 11.371J, 22.811J)
(Subject meets with 2.650J, 10.291J, 22.081J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 22.811J.
M. W. Golay, J. P. Freidberg

ESD.172J X PRIZE Workshop: Grand Challenges in Energy (New)
(Same subject as 1.818J, 2.65J, 10.391J, 11.371J, 22.811J)
Prereq: Permission of instructor
G (Fall)
3-0-6
Examines the intersection of incentives and innovation, drawing on economic models, historic examples, and analytic tools to help develop new prize concepts that can generate revolutionary progress in the area of energy. Limited to 30 graduate students by application; select upperclassmen with permission of instructor.
E. Wagner, D. Newman, F. Murray, K. Zolot, J. Shames, C. Cooney, R. Lester

ESD.173J X PRIZE Workshop: Grand Challenges in Health Care
(Same subject as SP.792J, HST.937J)
Prereq: Permission of instructor
G (Spring)
3-0-6
Examines the intersection of incentives and innovation, drawing on economic models, historic examples, and analytic tools to help develop new prize concepts that can generate revolutionary progress in the area of health care. Limited to 30 graduate students by application; select upperclassmen with permission of instructor.
E. Wagner, D. Newman, F. Murray, K. Zolot, J. Shames, C. Cooney

ESD.174 Applications of Technology in Energy and the Environment
Engineering School-Wide Elective Subject
(Offered under: 1.149, 2.63, 5.00, 10.579, 22.813, ESD.174)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.813.
J. Deutch, R. Lester

ESD.191J Cities and Regions: Urban Economics and Public Policy
(Same subject as 1.283J, 11.410J, 14.573J)
Prereq: 14.03 or 14.04
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 14.573J.
W. Wheaton

ESD.192J Analyzing and Accounting for Regional Economic Change
(Same subject as 1.284J, 11.481J)
Prereq: 14.03, 14.04
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.481J.
K. R. Polenske

ESD.193J Regional Socioeconomic Impact Analyses and Modeling
(Same subject as 1.285J, 11.482J)
Prereq: 11.481J or permission of instructor
G (Fall)
2-1-9 H-LEVEL Grad Credit
See description under subject 11.482J.
K. R. Polenske

TRANSPORTATION

ESD.21J Transportation Systems Analysis: Performance and Optimization
(Same subject as 1.200J, 11.544J)
Prereq: 1.010, permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 1.200J.
C. Barnhart, A. R. Odoni

ESD.210J Transportation Systems Analysis: Demand and Economics
(Same subject as 1.201J, 11.545J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 1.201J.
N. H. M. Wilson, M. Ben-Akiva

ESD.212J Demand Modeling
(Same subject as 1.202J)
Prereq: Permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit
See description under subject 1.202J.
Staff

ESD.213J Advanced Demand Modeling
(Same subject as 1.205J)
Prereq: 1.202 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.205J.
M. E. Ben-Akiva

ESD.215J Airline Schedule Planning
(Same subject as 1.206J, 16.77J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.206J.
C. Barnhart

ESD.216J Logistical and Transportation Planning Methods
(Same subject as 1.203J, 6.281J, 15.073J, 16.76J)
Prereq: 6.041
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.203J.

ESD.217J The Airline Industry
(Same subject as 1.232J, 15.054J, 16.71J)
Prereq: None
G (Fall)
3-0-9
See description under subject 16.71J.

ESD.221J An Introduction to Intelligent Transportation Systems
(Same subject as 1.212J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 1.212J.
J. Sussman

ESD.222J Transportation Policy and Environmental Limits
(Same subject as 1.253J, 11.543J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.253J.
J. Coughlin, F. Salvucci
ESD.224j Planning and Design of Airport Systems
(Same subject as 1.231j, 16.781j)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 1.231j.
R. de Neufville, A. R. Odoni

ESD.225j Urban Transportation Planning
(Same subject as 1.252j, 11.540j)
Prereq: 1.201j or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.252j.
J. Goentzel, C. Caplice

ESD.226j Public Transportation Systems
(Same subject as 1.258j, 11.541j)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.258j.
N. H. Wilson

ESD.227j Urban Spatial Structure,
Transportation, and Telecommunications I
(Same subject as 11.528j)
Prereq: None
G (Fall)
2-0-1 [P/D/F]
A combination of lectures and case studies covering the
strategic, management, and operating issues in
contemporary logistics and integrated supply
chain management. Includes: logistics strategy;
transportation, and telecommunications integration technologies.

ESD.228j Urban Transportation Planning
(Same subject as 1.252j, 11.540j)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.252j.
J. Goentzel, C. Caplice

ESD.229j Urban Spatial Structure,
Transportation, and Telecommunications I
(Same subject as 11.528j)
Prereq: None
G (Fall)
2-0-1 [P/D/F]
Covers the primary methods of analysis required
for supply chain management planning. The
class solves various real-life problems using
simulation, linear programming, integer
programming, regression, and other techniques. The
work is primarily team based with a final exam. Restricted to MEng in Logistics students.
J. Goentzel, C. Caplice, E. Blanco

ESD.260j Logistics Systems
(Same subject as 1.260j, 15.770j)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to supply chain management from both analytical and practical perspectives. Stressing a unified approach, the course allows
the student to develop a framework for making
intelligent decisions within the supply chain.
Key logistics functions are covered to include demand
planning, procurement, inventory theory and
control, transportation planning and execution,
reverse logistics, and flexible contracting. Concepts explored include postponement, portfolio management, dual sourcing, and others. Emphasis is placed on being able to recognize and manage risk, analyze various tradeoffs, and
model logistics systems.
Y. Sheffi, C. Caplice

ESD.261j Case Studies in Logistics and Supply Chain Management
(Same subject as 1.261j, 15.771j)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
A combination of lectures and cases covering the
strategic, management, and operating issues in
contemporary logistics and integrated supply
chain management. Includes: logistics strategy;
transportation, and telecommunications integration technologies.

ESD.262j Supply Chain Context
(Same subject as 1.262j)
Prereq: ESD.260 or permission of instructor
G (IAP)
2-0-4 [P/D/F]
Introduction to theory and practice of the core
functions of the enterprises that impact supply
chain management. Provides a basic understanding of strategy, industry structure, organization
behavior, and marketing highlighted in the
context of the supply chain. Uses lectures to
introduce core functions and cases to illustrate
the relationship and context for supply chain
management. This results in a basic tool set to
illustrate the theory and practice of analyzing
and managing the relationship between supply
chain management and the various functions of
business. Also provides a solid understanding of supply chain management in practice. Core
subject for MEng in Logistics.
J. Byrnes

ESD.263j Case Studies in Logistics and Supply Chain Management
(Same subject as 1.263j, 15.772j)
Prereq: Permission of instructor
G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit

ESD.264j Database, Internet, and Systems Integration Technologies
(Same subject as 1.264j)
Prereq: Permission of instructor
G (Fall)
5-0-7 H-LEVEL Grad Credit
See description under subject 1.264j.
G. Kocur

ESD.265j International Supply Chain Management
(Same subject as 1.265j, 2.965j, 15.765j)
Prereq: 1.260j, 1.261j, 1.262j, 15.760, or
permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring; first half of term)

ESD.266j Supply Chain Planning
(Same subject as 1.266j, 15.762j)
Prereq: 1.260j, 15.760, or 15.761
G (Spring)
2-0-4 H-LEVEL Grad Credit
See description under subject 15.762j.
S. C. Graves, D. Simchi-Levi

ESD.267j Manufacturing System and Supply Chain Design
(Same subject as 1.274j, 15.763j)
Prereq: 1.260j, 15.760, or 15.761
G (Spring)
2-0-4 H-LEVEL Grad Credit
See description under subject 15.763j.
S. C. Graves, D. Simchi-Levi

ESD.270j Studies in Transportation
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Individual advanced study of a topic in transportation systems, selected with the approval of the instructor.

J. Byrnes
ESD.271 Research Seminar in Transportation
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Discussion of current research at various stages of development, including problem definition, literature review, methodology, and evaluation of results. Intended for advanced doctoral students who have passed the general examination.

Staff

ESD.272J Design and Operation of Logistics Facilities and Networks
(Same subject as 1.272J)
Prereq: 1.260J or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (IAP)
2-0-1
Exploration of the technological and managerial issues involved in the design and operation of distribution and logistics physical facilities and associated information technology in an enterprise wise supply chain. Includes day-long site visits to logistics operations in the local area, as well as day-long software tutorials on commercial-grade software packages used in the design of logistics networks. The curriculum also includes lectures and case studies from faculty and professional logistics consultants focusing on the design and operation of efficient logistics facilities.

C. Caplice

ESD.273J Logistics and Supply Chain Management
(Same subject as 1.270J)
Prereq: Probability and linear programming
G (Fall)
3-0-9 H-LEVEL Grad Credit
Survey of Operations Research models and techniques developed for a variety of problems arising in logistical planning of multi-echelon systems. Focus on planning models for production/inventory/distribution strategies in general multi-echelon multi-item systems. Topics include vehicle routing problems, dynamic lot sizing inventory models, stochastic and deterministic multi-echelon inventory systems, the bullwhip effect, pricing models, and integration problems arising in supply chain management.

D. Simchi-Levi

ESD.290 Special Topics in Supply Chain Management
Prereq: ESD.260J, 1.260J, 15.770J, or permission of instructor
G (Spring)
3-0-3 H-LEVEL Grad Credit
Subject presents a range of advanced topics in integrated logistics and supply chain management. Conducted in a lecture-discussion format, with participation of corporate executives as guest lecturers. Students prepare industry assessment analyses and make formal classroom presentations. Specific topics alternate from year to year, but basic content includes procurement strategies and strategic sourcing, dynamic pricing and revenue management tactics, mitigation of supply chain risk through supply contracts, strategic outsourcing of supply chain chain functions and operations, management and operation of third party logistics providers, and management of supply chain security.

Y. Sheffi

SYSTEMS DESIGN AND MANAGEMENT

ESD.30J Engineering Apollo: The Moon Project as a Complex System
(Same subject as 16.89J, STS.471J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
4-0-8 H-LEVEL Grad Credit
See description under subject STS.471J.

D. Mindell, L. R. Young

ESD.301 Probability and Statistics
Prereq: None
G (IAP)
1-0-3 [P/D/F]
A highly-condensed review of topics from basic probability through calculus-based statistical analysis. It assumes previous probability and statistics course work, and is designed to be an intensive review for incoming SDM students. Limited to SDM students except by permission of instructor.

J. Orloff

ESD.32J Product Design and Development
(Same subject as 2.739J, 15.783J)
Prereq: 2.009, 15.760, 15.761, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 15.783J.

S. Eppinger, W. P. Seering

ESD.33 Systems Engineering
Prereq: Limited to SDM students except by permission of instructor
G (Summer)
2-1-6 H-LEVEL Grad Credit
Systems engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem including operations, performance, test, manufacturing, cost, and schedule. This subject emphasizes the links of systems engineering to fundamentals of decision theory, statistics, and optimization. Also introduces the most current, commercially successful techniques for systems engineering.

K. Katsikopoulos

ESD.34 System Architecture
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Covers principles and methods for technical system architecture. Presents a synthetic view including: the resolution of ambiguity to identify system goals and boundaries; the creative process of mapping form to function; and the analysis of complexity and methods of decomposition and re-integration. Industrial speakers and faculty present examples from various industries. Heuristic and formal methods are presented. Restricted to SDM students.

E. F. Crawley

ESD.340 Theory of System Architecture
Prereq: ESD.32J or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
4-2-6 H-LEVEL Grad Credit
Covers principles and methods for technical system architecture. Presents a synthetic view including: the resolution of ambiguity to identify system goals and boundaries; the creative process of mapping form to function; and the analysis of complexity and methods of decomposition and re-integration. Industrial speakers and faculty present examples from various industries. Heuristic and formal methods are presented.

A. L. Weigel
ESD.341J Architecting Software Systems
(Same subject as 1.125J)
Prereq: 1.00, 1.124J, or permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit
Software architecture and design of software-intensive systems. Targeted at future CTOs who must understand both the business and technical issues involved in architecting enterprise-scale systems. Students teams confront technically challenging problems. Lectures and readings cover core database, XML, web server components and browser issues in a distributed web service environment. Enrollment limited. J. Williams, D. Hartzband, A. Sanchez

ESD.342 Network Representations of Complex Engineering Systems
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Focus on understanding engineering systems using network models. Framing of the interplay between theory and experiment, leading to new knowledge about complex system architecture. Review of network literature, network methods in social science, and recent results in large network analysis. Discussion of key system concepts, including modularity, hierarchy, flexibility, and complexity. Examples of engineering systems, organizations, and social systems. Descriptions of real systems, such as software, railways, telephones, and large social systems. Definition of network metrics and MATLAB implementations of network analysis methods. Readings and discussion of current network research literature, including identification of needed research. Semester-long project analyzing a real system using these methods. C. Magee, J. Moses, D. Whitney

ESD.344 Real Options for Product and Systems Design (New)
Prereq: None
G (Spring; second half of term)
3-0-3
The theory and practice of implementing flexibility (real options) in the design of products and systems. Key topics include the recognition of uncertainty, the identification of best opportunities for flexibility, the valuation of these options and their effective implementation. Students apply these concepts and procedures to problems of their choosing. Designed to help students launch their theses. R. de Neufville

ESD.351J Air Transportation Systems Architecting (New)
(Same subject as 16.886J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-2-7 H-LEVEL Grad Credit
See description under subject 16.886J.
R. J. Hansman, A. Haggerty, R. Liebeck

ESD.352J Space Systems Engineering
(Same subject as 16.89J)
Prereq: 16.851, 16.892, or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
4-2-6 H-LEVEL Grad Credit
See description under subject 16.89J.
E. F. Crawley, D. W. Miller

ESD.355J Concepts in the Engineering of Software
(Same subject as 16.355J)
Prereq: 16.35, 16.880J/ESD.33J, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.355J.
N. G. Leveson

ESD.36 System Project Management
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Focuses on management principles, methods, and tools to effectively plan and implement successful system and product development projects. Material is divided into four major sections: project preparation, planning, monitoring, and adaptation. Brief review of classical techniques such as CPM and PERT. Emphasis on new methodologies and tools such as Design Structure Matrix, probabilistic project simulation, as well as project system dynamics. Topics are covered from strategic, tactical, and operational perspectives. Industrial case studies expose factors that are typical drivers of success and failure in complex projects with both hardware and software content. Term projects analyze and evaluate past and ongoing projects in student’s area of interest. Projects used to apply concepts discussed in class. O. de Weck, J. Lyneis

ESD.361J Cost Estimation and Measurement Systems
(Same subject as 16.866J)
Prereq: ESD.301 or a basic understanding of statistics and permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Focuses on principals of cost estimation and measurement systems with specific emphasis on parametric models. Theories from the fields of hardware, software, systems engineering, Systems of Systems, and enterprise science will be applied to a variety of contexts (i.e., aerospace, IT, manufacturing). Material is divided into five major sections: cost estimation fundamentals, parametric model development calibration, economic principles, measurement systems, and government/policy issues. R. Valerdi

ESD.379 Systems Engineering Taxonomy and Semantics in Commercial Domains
Prereq: None
G (Fall, Spring)
1-0-3 [P/D/F]
The application of systems engineering practices is increasing in commercial enterprises, but the semantics and process frameworks for ‘commercial systems engineering’ often appear to be quite different from the process and taxonomy developed in defense and aerospace, arguably the birthplace of modern systems engineering. Examines how systems engineering practices are employed in commercial industries, including product and service development and delivery. Special project. Enrollment limited to 5. P. Hale

ESD.38J Enterprise Architecting
(Same subject as 16.855J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Topics in architecting holistic and highly networked enterprise structures including: organizational structure; business models; organizational culture/behavior; enterprise architecture frameworks and standards; policy and process infrastructure; information technologies; and knowledge management. Explores how the practices and heuristics of systems architecting may be extended and adapted for enterprise architecting, along with discussions of evolving methods and toolsets. D. Nightingale, D. Rhodes
ESD.40 Product Design and Development
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Modern tools and methods for product design and development. Teams of SDM and certificate program students conceive, design, and prototype a physical product. Cases and exercises reinforce key ideas. Topics include product planning, identifying customer needs, concept generation, product architecture, industrial design, concept design, and design-for-manufacturing. Restricted to SDM students or permission of instructor.
M. Yang, P. Hale

ESD.41 Infrastructure Systems
Prereq: Permission of instructor
G (Fall)
2-0-4 Can be repeated for credit
Examination of networked infrastructure systems from different sectors including land transport, air transport, electric power and communications. Development of generalizable frameworks, analysis approaches and methodologies for infrastructure planning, design and operation that provide improved flexibility, safety, security, robustness, and operational efficiency.
R. J. Hansman, D. Roos

TECHNOLOGY

ESD.51J Software and Computation for Simulation
 SAME SUBJECT AS 1.124J, 2.091J
Prereq: 1.00 or knowledge of an object-oriented language
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.124J.
J. R. Williams

ESD.53J The Impact of Globalization on the Built Environment
 SAME SUBJECT AS 1.463J, 11.342J
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit
See description under subject 1.463J.
F. Moavenzadeh, D. Wolff

ESD.55 Management of Infrastructure Systems
Prereq: Prep in infrastructure systems/control theory/system dynamics/network analysis or instructor consent
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Infrastructure systems such as transportation, telecommunication, and electric power systems have become a crucial aspect of modern society. Investigates techniques from control theory and optimization that help develop and manage these systems. Although each system has unique features that need to be understood, course considers how some tools have general applicability. Studies concepts such as stability, robustness, resource allocation, stakeholder equity, and arguments for centralization/ decentralization of components.
H. Balakrishnan

ESD.565J Evolution Towards Web 3.0 and the Emergence of Management 3.0
SAME SUBJECT AS 15.565J
Prereq: Permission of instructor
G (Spring)
3-0-6 Can be repeated for credit
See description under subject 15.565J.
S. Madnick

ESD.57 Technology-based Business Innovation
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
How to leverage major technology advances to significantly transform a business in the marketplace. Focus on major issues a business must deal with to transform its technical and market strategies successfully, including the organizational and cultural aspects that often cause such business transformations to fail.
Draws from concrete experiences of IBM’s major transformation in the late 1990s, when it aggressively embraced the Internet and came up with its e-business strategy.
I. Wladawsky-Berger

ESD.58J Disruptive Technologies: Predator or Prey?
SAME SUBJECT AS 15.365J
Prereq: None
G (Spring)
3-0-6
See description under subject 15.365J.
J. M. Utterback

ESD.60 Creating High-Velocity Organizations
Prereq: Permission of instructor
G (Summer)
2-0-6
Examines methods stand organizations use to generate and sustain more value, with less effort and fewer resources, than their rivals. Methods illustrated with examples from heavy and high-tech manufacturing, new product development and manufacturing, health care and military. Addresses the role of lean, six sigma, and other quality programs. Preference to students in LGO, SDM, and 2N master’s programs.
S. Spear

ESD.61J Integrating The Lean Enterprise
SAME SUBJECT AS 16.852J
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.852J.
D. Nightingale

ESD.62J Introduction to Lean Six Sigma Methods
SAME SUBJECT AS 16.660J
Prereq: None
G (Spring)
1-1-0 [P/D/F]
See description under subject 16.660J.
A. L. Weigel, E. M. Murman

ESD.63J Control of Manufacturing Processes
SAME SUBJECT AS 2.830J, 6.780J
Prereq: 2.008, 2.810, 6.041, 6.152J, or 15.064J
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.830J.
D. E. Hardt, D. S. Boning

ESD.64J Product Design
SAME SUBJECT AS 2.744J
Prereq: 2.009
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-1-8 H-LEVEL Grad Credit
See description under subject 2.744J.
D. R. Wallace
METH O D S

ESD.70J Engineering Economy Module
(Same subject as 1.145J)
Prereq: None
G (Fall)
1-0-2 [P/D/F]
Presentation of the spreadsheet mechanics for the efficient calculation of discounted cash flows and related metrics of project worth; the use of data tables as means of exploring sensitivity analysis; and of simulation to develop the value of options. Intensive module designed for students who are not familiar with the efficient use of Excel. Presented intensively over first week of term.
* R. de Neufville

ESD.71 Engineering Systems Analysis for Design
Engineering School-Wide Elective Subject
(Offered under: 1.146, 3.56, 16.861, ESD.71)
Prereq: 1.145J or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Covers theory and methods to identify, value and implement "real options" in technological projects: systems modeling, definition of uncertainties, simulation of performance for scenarios, screening models to identify desirable flexibility, and multi-dimensional economic evaluation. Students work to develop and demonstrate proficiency through an extended application of their own choosing.
* R. de Neufville

ESD.72 Engineering Risk-Benefit Analysis
Engineering School-Wide Elective Subject
(Offered under: 1.155, 2.963, 3.577, 6.938, 10.816, 16.862, 22.82, ESD.72)
Prereq: Calculus II (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit
Emphasis on three methodologies pertaining to decision making in the presence of uncertainty: reliability and probabilistic risk assessment (RPRA), decision analysis (DA), and cost-benefit analysis (CBA). Risks of particular interest are those associated with large engineering projects such as the development of new products; the building, maintenance and operation of nuclear reactors and space systems. Presents and interprets some of the frameworks helpful for balancing risks and benefits in the situations that typically involve human safety, potential environmental effects, and large financial and technological uncertainties. Review of elementary probability theory and statistics included.
* G. E. Apostolakis
between technical systems and the social/political context in which such systems operate.

B. Morrison

**ESD.750J** System Optimization and Analysis for Manufacturing
(Same subject as 2.851J, 15.066J)
Prereq: Calculus II (GIR)
G (Summer)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.066J.
*S. C. Graves, J. P. Clark, J. Gallien*

**ESD.751 J** Engineering Probability and Statistics
(Same subject as 15.064J)
Prereq: Calculus II (GIR)
G (Summer)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.064J.
*A. I. Barnett, R. Welsch*

**ESD.753 J** Statistical Learning and Data Mining
(Same subject as 15.077J)
Prereq: 6.431, 15.085, or 18.046; 18.06 or 18.700
G (Spring)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.077J.
*R. E. Welsch*

**ESD.754 J** Data Mining: Finding the Data and Models that Create Value (New)
(Same subject as 15.062J)
Prereq: 15.060, 15.074, or 15.075
G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
See description under subject 15.062J.
*R. Welsch*

**ESD.755 J** Statistical Reasoning and Data Modeling
(Same subject as 15.074J)
Prereq: 6.041, 15.060, or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.074J.
*R. E. Welsch*

**ESD.756 J** Statistical Methods in Experimental Design
(Same subject as 16.470J)
Prereq: 6.041 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.470J.
*M. L. Cummings*

**ESD.762 Systems Optimization**
Prereq: None
G (Spring)
2-0-4 H-LEVEL Grad Credit
Application-oriented introduction to systems optimization focusing on understanding system tradeoffs. Introduces modeling methodology (linear, integer and nonlinear programming) and simulation methods, with applications in production planning and scheduling, inventory planning and supply contracts, logistics network design, facility sizing and capacity expansion, yield management, electronic trading and finance.
*Staff*

**ESD.763 Operations and Supply Chain Management**
Prereq: Permission of instructor
G (Summer)
3-0-6 H-LEVEL Grad Credit
Objectives are to develop modeling skills and to provide new concepts and problem-solving tools, applicable to the design and planning of supply chains as well as manufacturing systems.
*Staff*

**ESD.765 J** Multidisciplinary System Design Optimization
(Same subject as 16.888J)
Prereq: 18.085 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
*O. de Weck, K. E. Willcox*

**ESD.773 J** Human Factors Engineering (New)
(Same subject as 16.453J)
(Subject meets with 16.400)
Prereq: None. Coreq: 16.06 or 2.010
G (Spring)
3-1-8 H-LEVEL Grad Credit
See description under subject 16.453J.
*M. L. Cummings*

**ESD.774 J** Human Supervisory Control of Automated Systems
(Same subject as 16.422J)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-1-8 H-LEVEL Grad Credit
See description under subject 16.422J.
*M. L. Cummings*

**ESD.775 J** Human-Computer Interface Design Colloquium (New)
(Same subject as 16.475J)
Prereq: None.
G (Summer)
3-1-8 H-LEVEL Grad Credit
See description under subject 16.475J.
M. L. Cummings

**ESD.80 Seminar in Technology Policy Research**
Prereq: ESD.10
G (Spring)
2-0-1 H-LEVEL Grad Credit
Presentations by students, faculty and guest speakers of ongoing research related to current issues in technology and policy. Specific topics determined by research of participants and by new and important directions in technology and policy.
*R. Kirchain*
ESD.801 Leadership Development
Prereq: Permission of instructor
G (Fall)
1-1-1 [P/D/F]
Seminar environment created to develop leadership capabilities. An initial Outward Bound experience builds trust, teamwork and communications. Readings and assignments emphasize the characteristics of great leadership. Global leaders participate in the Global Leadership Lunch series to share their experiences and recommendations. Discussions explore leadership development. Culminates in a personal leadership plan. Restricted to entering students in the Technology and Policy program or instructor permission.
D. Newman

ESD.802 SDM Thesis Seminar
Prereq: Permission of instructor
G (Spring)
2-0-1 [P/D/F] H-LEVEL Grad Credit
Designed to assist SDM students in discovering research areas of interest and matching these interests with faculty and organization research projects. At the end of the semester, the student has faculty advisor, research project, proposal and plan. Restricted to SDM students.
P. Hole

ESD.803 Know Thyself Leadership Workshop
Prereq: None
G (Fall)
2-0-4
Designed to enhance your ability to manage and lead in challenging times through a series of self assessment instruments, case studies, and workshops. The objectives are to increase awareness of your strengths and weaknesses as a leader, provide a battery of instruments and surveys to help one understand the way one operates in an organizational setting, and offer strategies and tips on how to leverage one’s strengths and work on areas in need of development. Morning section restricted to students in the MLOG program.
S. Saar

ESD.804 Know Thy Team: Leadership Skill Building Seminar
Prereq: None
G (IAP, Spring)
2-0-1
Provides students with the framework and strategies needed to foster and sustain team effectiveness. Examines research that assesses the effectiveness of teams. Explores team dynamics, with emphasis on understanding the roles of team members and the team leader. Integrates team dynamics into instruction on managing transition, creating a compelling vision, designing a supportive structure, communicating effectively, coaching team members, sustaining performance. Includes role-playing exercises. Restricted to students in the MLOG program during IAP.
S. Saar

ESD.81 Studies in Transportation and Logistics
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Individual advanced study of a topic in logistics systems selected with the approval of the instructor.

ESD.811 Technology Policy Internship Seminar
Prereq: ESD.10
G (Fall)
1-1-1 [P/D/F] H-LEVEL Grad Credit
Seminar examines what technology policy is in practice. Considers the question of “Who achieves what, when, how, and why?” regarding technology policy. Students who completed summer internships present and dissect their experiences with special reference to specific cases in which they participated.
F. Field

ESD.83 Doctoral Seminar in Engineering Systems
Prereq: ESD.10 or permission of instructor
G (Fall)
6-0-6 H-LEVEL Grad Credit
Examines core theory and contextual applications of the emerging field of Engineering Systems. Focus on doctoral-level analysis of scholarship on key concepts such as complexity, uncertainty, fragility, and robustness, as well as a critical look at the historical roots of the field and related areas such as systems engineering, systems dynamics, agent modeling, and systems simulations. Contextual applications range from aerospace to technology implementation to regulatory systems to large-scale systems change. Special attention given to the interdependence of social and technical dimensions of engineering systems. Restricted to students enrolled in doctoral programs.
C. Magee, J. Sussman

ESD.832 Mining Data, Modeling Systems, Making Impact
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Seminar on modeling engineering-economic systems for real-world applications. Successful applications require data analysis, systems modeling and judgment of importance. Introduction to data mining techniques and software. Cases of real world applications of systems models used to demonstrate the art.
R. C. Larson, N. Patel

ESD.85J Integrating Doctoral Seminar on Emerging Technologies
(Same subject as 17.312J, STS.461J)
Prereq: Permission of instructor
G (Spring)
2-0-7 H-LEVEL Grad Credit
Team-taught subject for doctoral students working on emerging technologies at the interface of technology, policy and societal issues. Integrates concepts of research strategy and design from a variety of disciplines. Addresses problem identification and formulation of research topics, the role of qualitative and quantitative research methods, and the use of various data collection techniques. Focuses on students’ thesis proposals, faculty-student study panels, critical evaluation of research design, and ethical issues in conducting research and gathering data.
K. Oye

ESD.86J Models, Data and Inference for Socio-Technical Systems
(Same subject as 15.078J)
Prereq: ESD.83, 6.041, or permission of instructor
G (Spring)
3-0-9
Use data and systems knowledge to build models of complex socio-technical systems for improved system design and decision-making. Enhance model-building skills, including: review and extension of functions of random variables, Poisson processes, and Markov processes. Move from applied probability to statistics via Chi-squared t and f tests, derived as functions of random variables. Review classical statistics, hypothesis tests, regression, correlation and causation, simple data mining techniques, and Bayesian vs. classical statistics. Class project. Enrollment limited to 25.
R. Larson, R. Welsch
ESD.862 Modeling Risk, Dynamics, and Decisions
Prereq: ESD.86 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Covers advanced methods for modeling risk and decision-making under uncertainty. Topics include Monte Carlo methods, Markov chain Monte Carlo, dynamic and stochastic optimization, and advanced topics in simulation. Applications drawn primarily from energy and environmental systems modeling.
M. Webster

ESD.863J System Safety
(Same subject as 16.863J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.863J.
N. G. Leveson

ESD.865 Seminar in Energy Systems Analysis
(New)
Prereq: 15.011, 14.003, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Examines advanced topics in the modeling and analysis of environmental and energy systems. Topics vary, but may include alternative design of environmental markets, modeling of electric power systems, analysis of alternative fuels, and coupling of environmental and energy systems. Previous coursework in microeconomics required.
M. Webster

ESD.87 Social Science Concepts and Methods
(New)
Prereq: ESD.83, ESD.86; or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to social science approaches to developing questions, designing research, and collecting data about complex systems. Overview of the different social science paradigms for developing research questions, as well as issues of measurement and research design. Covers various modes of data collection with emphasis on how the different elements of research design contribute to more powerful and persuasive results. Students develop skills in designing and completing social science-based research, as well as in critically assessing related work. Limited to 30.
L. D’Ambrosio, N. Leveson

ESD.875J Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development
(Same subject as 2.875J)
Prereq: 2.008
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.875J.
D. E. Whitney

SPECIAL SUBJECTS

ESD.910–ESD.920 Research in Engineering Systems Division
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
For research assistants in the Engineering Systems Division when assigned research is not used for thesis, but is approved for academic credit. Credit for this subject may not be used for any degree granted by ESD.
Information: N. Leveson

ESD.921–ESD.929 Teaching in Engineering Systems Division
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
For teaching assistants in Engineering Systems Division in recognition of educational value derived from satisfactory performance of assigned duties, and for other qualified students interested in teaching as a career. Laboratory, tutorial, or classroom teaching under supervision of a faculty member. Credit for this subject may not be used for any degree granted by ESD.
Information: N. Leveson

ESD.930–ESD.933 Special Graduate Studies in Engineering Systems Division
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
ESD.934–ESD.939 Special Graduate Studies in Engineering Systems Division
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
ESD.940–ESD.943 Special Graduate Studies in Engineering Systems Division
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
ESD.944–ESD.949 Special Graduate Studies in Engineering Systems Division
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for individual or group study of advanced topics in ESD not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad hoc basis subject to ESD approval.
Information: N. Leveson

ESD.950–ESD.951 Special Undergraduate Studies in Engineering Systems Division
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Opportunity for individual or group study of topics in Engineering Systems Division not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad hoc basis subject to ESD approval.
Information: N. Leveson

ESD.955 Special Undergraduate Studies in Engineering Systems Division
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Opportunity for individual or group study of topics in Engineering Systems Division not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad hoc basis subject to ESD approval.
S. Luperfoy
ESD.956 Special Undergraduate Studies in Engineering Systems Division
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Opportunity for individual or group study of topics in Engineering Systems Division not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad hoc basis subject to ESD approval.
Information: N. Leveson

ESD.ThG ESD Graduate Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research, leading to the writing of an SM or PhD thesis to be arranged by the student with a member of the ESD faculty. A minimum of 24 thesis units are required for the SM degree.
R. de Neufville

ESD.UGR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Undergraduate research opportunities in Engineering Systems.
Information: N. Leveson
IMPORTANT NOTES regarding preclinical subjects (HST.011–HST.185 and HST.191):

Students not enrolled in an HST degree program may take preclinical subjects if space is available. Non-HST students are limited to one HST preclinical course and must provide justification for enrolling in this course. They must obtain permission from the course director and the associate master of HST at HMS.

These subjects are scheduled according to the Harvard Medical School academic calendar, which differs from the MIT calendar. Students whose graduation depends upon completing one or more of these subjects should take particular care regarding the schedule.

HST.011 Human Functional Anatomy
(Subject meets with HST.010)
Prereq: Permission of instructor
G (Fall)
3-11-10 H-LEVEL Grad Credit

Lectures, detailed laboratory dissections, and projections provide a thorough exploration of the gross structure and function of the human body. Fundamental principles of bioengineering are employed to promote analytical approaches to understanding the body’s design. The embryology of major organ systems is presented, together with certain references to phylogenetic development, as a basis for comprehending anatomical complexity. Correlation clinics stress both normal and abnormal functions of the body and present evolving knowledge of genes responsible for normal and abnormal anatomy. Lecturers focus on current problems in organ system research. Only HST students may register under HST.010, graded P/D/F. Enrollment restricted to graduate students.

L. Gehrke

HST.021 Musculoskeletal Pathophysiology
(Subject meets with HST.020)
Prereq: Permission of instructor
G (IAP)
3-0-3 H-LEVEL Grad Credit

Growth and development of normal bone and joints, the process of mineralization, the biophysics of bone and response to stress and fracture, calcium and phosphate homeostasis and regulation by parathyroid hormone and vitamin D, and the pathogenesis of metabolic bone diseases and disease of connective tissue, joints, and muscles, with consideration of possible mechanisms and underlying metabolic derangements. Only HST students may register under HST.020, graded P/D/F. Enrollment limited. Open only to medical and graduate students.

M. Bouxsein, M. Seton

HST.030 Principles and Practice of Human Pathology
(Subject meets with HST.030)
Prereq: Permission of instructor; Biology (GIR), Physics I (GIR), or Physics II (GIR)
G (Fall)
4-4-8 H-LEVEL Grad Credit

Introduction to the functional structure of normal cells and tissues, pathologic principles of cellular adaptation and injury, inflammation, circulatory disorders, immunologic injury, infection, genetic disorders, and neoplasia in humans. Lectures, conferences emphasizing clinical correlations and contemporary experimental biology. Laboratories with examination of microscopic and gross specimens, and autopsy case studies emphasizing modern pathology practice. Only HST students may register under HST.030, graded P/D/F. Enrollment limited.

R. N. Mitchell

HST.031 Human Pathology
(Subject meets with HST.030)
Prereq: Permission of instructor; Biology (GIR), Physics I (GIR), or Physics II (GIR)
G (Fall)
4-4-8 H-LEVEL Grad Credit

Provides a comprehensive overview of human pathology with emphasis on mechanisms of disease and modern diagnostic technologies. Topics include general mechanisms of disease (inflammation, infection, immune injury, transplantation, genetic disorders and neoplasia); pathology of lipids, enzymes, and molecular transporters; pathology of major organ systems; and review of diagnostic tools from surgical pathology to non-invasive techniques such as spectroscopy, imaging, and molecular markers of disease. The objectives of this subject are achieved by a set of integrated lectures and laboratories, as well as a student-driven term project leading to a formal presentation on a medical, socioeconomic, or technological issue in human pathology. Only HST students enrolled in specific degree programs may register under HST.034, graded P/D/F. Credit cannot also be received for HST.030 or HST.031.

K. Badizadegan, G. Tearney

HST.034 Mechanisms of Microbial Pathogenesis
(Subject meets with HST.040)
Prereq: Biology (GIR), 7.05, permission of instructor
G (Fall)
3-6-5 H-LEVEL Grad Credit

Deals with the mechanisms of pathogenesis of bacteria, viruses, and other microorganisms. Approach spans mechanisms from molecular to clinical aspects of disease. Topics selected for intrinsic interest and cover the demonstrated spectrum of pathophysiologic mechanisms. Only HST students may register under HST.040, graded P/D/F. Enrollment limited.

C. Crumpacker II, H. Simon

HST.040 Human Pathology
(Subject meets with HST.040)
Prereq: Biology (GIR), 7.05, permission of instructor
G (Spring)
6-0-6 H-LEVEL Grad Credit

Pathology and physiopathology of the human endocrine system. Three hours of lecture and section each week concern individual parts of the endocrine system. Topics include assay techniques, physiological integration, etc. At frequent clinic sessions, patients are presented who demonstrate clinical problems considered in the didactic lectures. Only HST students may register under HST.060, graded P/D/F. Enrollment limited.

W. Katzly, A. Goldfine

HST.061 Endocrinology
(Subject meets with HST.060)
Prereq: Biology (GIR), 7.05, permission of instructor
G (Spring)
6-0-6 H-LEVEL Grad Credit

Physiology and pathophysiology of the human endocrine system. Three hours of lecture and section each week concern individual parts of the endocrine system. Topics include assay techniques, physiological integration, etc. At frequent clinic sessions, patients are presented who demonstrate clinical problems considered in the didactic lectures. Only HST students may register under HST.060, graded P/D/F. Enrollment limited.

W. Katzly, A. Goldfine
ing of the physiology, endocrinology, and pathology of human reproduction. Emphasis is on the role of technology in reproductive science. Suggestions for future research contributions in the field are probed. Students become involved in the wider aspects of reproduction, such as prenatal diagnosis, in vitro fertilization, abortion, menopause, contraception and ethics relating to reproductive science. Only HST students may register under HST.070, graded P/D/F.

H. Klapholz

HST.081 Hematology
(Subject meets with HST.080)
Prereq: 7.05, permission of instructor
G (Spring; second half of term)
3-6-4 H-LEVEL Grad Credit

An intensive survey of the biology, physiology, and pathophysiology of blood with systematic consideration of hematopoiesis, white blood cells, red blood cells, platelets, coagulation, plasma proteins, and hematologic malignancies. Emphasis given equally to didactic discussion and analysis of clinical problems. Only HST students may register under HST.080, graded P/D/F. Enrollment limited.

D. J. Kuter, J. O. Jacobson, J. Bradner, R. Rosovsky

HST.091 Cardiovascular Pathophysiology
(Subject meets with HST.090)
Prereq: HST.030 or HST.031; permission of instructor
G (Spring)
3-3-9 H-LEVEL Grad Credit

Normal and pathologic physiology of the heart and vascular system. Emphasis includes hemodynamics, electrophysiology, gross pathology, and clinical correlates of cardiovascular function in normal and in a variety of disease states. Special attention given to congenital, rheumatic, valvular heart disease and cardiomyopathy. Only HST students may register under HST.090, graded P/D/F. Enrollment limited.

E. Edelman

HST.101 Respiratory Pathophysiology
(Subject meets with HST.100)
Prereq: Biology (GIR), 7.05, Physics I (GIR), permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit

Lectures, seminars, and laboratories cover the histology, cell biology, and physiological function of the lung with multiple examples related to common diseases of the lung. A quantitative approach to the physics of gases, respiratory mechanics, and gas exchange is provided to explain pathological mechanisms. Use of medical ventilators is discussed in lecture and in laboratory experiences. For MD candidates and other students with background in science. Only HST students may register under HST.100, graded P/D/F. Enrollment limited.

J. Drazen, S. Loring, A. Malhotra

HST.111 Renal Pathophysiology
(Subject meets with HST.110)
Prereq: Biology (GIR), 7.05, permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit

Considers the normal physiology of the kidney and the pathophysiology of renal disease. Renal regulation of sodium, potassium, acid, and water balance are emphasized as are the mechanism and consequences of renal failure. Included also are the pathology and pathophysiology of clinical renal disorders such as acute and chronic glomerulonephritis, pyelonephritis, and vascular disease. New molecular insights into transporter mutations and renal disease are discussed. Only HST students may register under HST.110, graded P/D/F. Enrollment limited.

J. Seifert

HST.121 Gastroenterology
(Subject meets with HST.120)
Prereq: Biology (GIR), 7.05, Physics I (GIR), permission of instructor
G (Fall)
3-6-4 H-LEVEL Grad Credit

Presents the anatomy, physiology, biochemistry, biophysics, and bioengineering of the gastrointestinal tract and associated pancreatic, liver, and biliary systems. Emphasis on the molecular and pathophysiological basis of disease where known. Covers gross and microscopic pathology and clinical aspects. Formal lectures given by course faculty, with some guest lectures by local experts. Selected seminars conducted by students with supervision of faculty. Only HST students may register under HST.120, graded P/D/F. Enrollment limited.

M. C. Carey

HST.140 Molecular Medicine
Prereq: 7.05
G (Fall)
2-0-4 [P/D/F] H-LEVEL Grad Credit

Conducted as a seminar to study a variety of human diseases and the underlying molecular, genetic, and biochemical basis for the pathogenesis and pathophysiology of the disorders. Lectures by faculty and seminars conducted by students, with tutorials and supervision by faculty. Patients presented when feasible. Appropriate for students who have had a course in biochemistry and/or molecular biology.


HST.147 Human Biochemistry and Metabolic Diseases
(Subject meets with HST.146)
Prereq: Permission of instructor
G (IAP)
3-0-3 H-LEVEL Grad Credit

First-year graduate level intensive subject in human biochemistry and physiological chemistry that focuses on intermediary metabolism, structures of key intermediates and enzymes important in human disease. Subject is divided into four areas: carbohydrates, lipids, amino acids and nucleic acids. The importance of these areas is underscored with examples from diseases and clinical correlations that are introduced by clinician-scientists. Only HST students may register under HST.146, graded P/D/F. Enrollment limited.

D. T. McLaughlin, C. N. Serhan

HST.150 Molecular Medicine
Prereq: Biology (GIR), 7.05, Physics I (GIR), permission of instructor
G (IAP)
3-0-9 H-LEVEL Grad Credit

An introduction to pharmacology. Topics include mechanisms of drug action, dose-response relations, pharmacokinetics, drug delivery systems, drug metabolism, toxicity of pharmaceutical agents, drug interactions, and substance abuse. Selected agents and classes of agents examined in detail. BEP students must register for HST.151 (graded) other HST students may register under HST.150 (P/D/F). Course follows HMS calendar. Restricted to HST MD, HST MEMP or HST BEP students.

C. Rosow, G. Forman, G. Strichartz
HST.161 Molecular Biology and Genetics in Modern Medicine
(Subject meets with HST.160)
Prereq: Biology (GIR), 7.05
G (Fall)
4-0-8 H-LEVEL Grad Credit
Foundation for understanding the relationship between molecular biology, developmental biology, genetics, genomics, bioinformatics, and medicine. Develops explicit connections between basic research, medical understanding, and the perspective of patients. Principles of human genetics reviewed. Translation of clinical understanding into analysis at the level of the gene, chromosome and molecule; the concepts and techniques of molecular biology and genomics; and the strategies and methods of genetic analysis, including an introduction to bioinformatics. Extends beyond basic principles to current research activity in human genetics. Only HST students may register under HST.160, graded P/D/F.
A. Giersch, D. Hausman

HST.176 Cellular and Molecular Immunology
(Subject meets with HST.175)
Prereq: 7.05
G (Fall)
4-0-8 H-LEVEL Grad Credit
Covers cells and tissues of the immune system, lymphocyte development, the structure and function of antigen receptors, the cell biology of antigen processing and presentation including molecular structure and assembly of MHC molecules, lymphocyte activation, the biology of cytokines, leukocyte-endothelial interactions, and the pathogenesis of immunologically mediated diseases. Consists of lectures and tutorials in which clinical cases are discussed with faculty tutors. Details of each case covering a number of immunological issues in the context of disease are posted on a student website. Sections are integrated with HST.031. Only HST students may register under HST.175, graded P/D/F. Enrollment limited to 45.
S. Pillai

HST.186–HST.187 Special Subjects in Health Sciences and Technology
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

HST.188–HST.189 Special Subjects in Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for group study of advanced subjects related to health sciences and technology not otherwise included in the curriculum. Offerings are initiated by HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
J. Greenberg

HST.191 Introduction to Biostatistics and Epidemiology
(Subject meets with HST.190)
Prereq: Calculus II (GIR)
G (IAP)
3-0-3 H-LEVEL Grad Credit
Fundamentals of biostatistics and epidemiology. Trains students how to comprehend, critique and communicate findings from biomedical literature. How to assess the importance of chance in the interpretation of experimental data. Topics include probability theory, normal sampling, chi-squared and t-tests, analysis of variance, linear regression and survival analysis, as well as how to perform elementary calculations using the statistical package STATA. How to identify and prevent bias in observational studies. Causal inference, types of bias (confounding, selection and information bias), key study designs (randomized trials, cohort and case-control studies, and screening programs). Only HST students may register under HST.190, graded P/D/F. Enrollment limited; restricted to medical and graduate students.
R. Betensky, M. Hernan

HST.196 Teaching Health Sciences and Technology
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
For teaching assistants in HST where the teaching assignment is approved for academic credit by the department.
J. V. Bonventre, M. L. Gray

HST.198 Special Topics in Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for study of topics related to HST but not included elsewhere in the catalog. Registration under this subject normally used for situations involving individual study under supervision of a faculty member, but may, when appropriate, be used for small study groups. Normal registration is for 12 units.
J. Greenberg

HST.199 Research in Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
For research assistants in HST where the assigned research is approved for academic credit by the department. Hours are arranged with research supervisor.

HST.200 Introduction to Clinical Medicine
Prereq: Permission of instructor
G (Spring)
9-25-12 [P/D/F] H-LEVEL Grad Credit
February through May, Monday, Wednesday, Friday. Students learn the basic skills involved in examination of the patient and are introduced to history taking and patient interview. Students exposed to clinical problems in medicine, surgery, and pediatrics in groups of two or three students under one faculty member. Findings reported through history taking and oral presentation of the cases to the class. An intensive subject serving as prerequisite to clinical clerkships. Restricted to MD program students.
W. H. Churchill, E. Whang, J. Kosowsky

HST.201 Introduction to Clinical Medicine and Medical Engineering I
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
0-20-0 [P/D/F] H-LEVEL Grad Credit
Develop skills in patient interviewing and physical examination; become proficient at organizing and communicating clinical information in both written and oral forms; begin integrating history, physical, and laboratory data with pathophysiologic principles; and become familiar with the clinical decision-making process and broad economic, ethical, and sociological issues involved...
in patient care. There are two sections: one at Mount Auburn Hospital during IAP, and one at West Roxbury VA Hospital beginning in summer. Restricted to MEMP students. 

HST.202 Introduction to Clinical Medicine and Medical Engineering II

Prereq: HST.201
G (Fall, IAP, Spring, Summer) 
0-20-0 [P/D/F] H-LEVEL Grad Credit

Strengthens the skills developed in HST.201 through a six-week clerkship in medicine at a Harvard-affiliated teaching hospital. Students serve as full-time members of a ward team and participate in longitudinal patient care. In addition, students participate in regularly scheduled teaching conferences focused on principles of patient management. Restricted to MEMP students. 

V. Pronio-Stelluto, R. G. Mark, J. Strymish

HST.203 Clinical Experience in Medical Engineering and Medical Physics

Prereq: HST.201, HST.202
G (Fall, IAP, Spring, Summer) 
0-12-0 [P/D/F] H-LEVEL Grad Credit

An individually arranged full-time one-month directed study in a clinical environment where active medical engineering/medical physics investigation is in progress. Students engage in patient care, particularly those aspects that interface closely with technology. Students also focus on in-depth exploration of the technical and research area. A project proposal is required at time of registration. Term paper required. 

E. N. Brown

HST.204 Industrial Experience in Medical Engineering and Medical Physics

Prereq: HST.572
G (Fall, IAP, Spring, Summer) 
0-12-0 [P/D/F] H-LEVEL Grad Credit

An individually arranged full-time eight week (or longer) internship in an industrial environment in the field of medical engineering/medical physics. Students participate in a clinically related research and/or development project. Students required to attend a series of industry-related seminars during the term before the internship. A term paper and final presentation are required. 

J. Weaver

HST.205 Enterprise Experience in Medical Engineering & Medical Physics

Prereq: HST.572
G (Fall, IAP, Spring, Summer) 
0-12-0 [P/D/F]

An individually arranged full-time one-month directed study in a commercial environment where active medical engineering/medical physics commercialization is in progress. Students are actively engaged in biomedical enterprise, particularly the due diligence process that critically examines the medical need, market size, patient and/or physician technology foundation, intellectual property, reimbursement issue and competition from existing and pending biomedical technologies. Term paper required. 

J. Weaver

HST.211 Biomedical Enterprise Clinical Experience I

Prereq: Permission of instructor
G (IAP) 
3-0-3 H-LEVEL Grad Credit

Provides students with an understanding of the strategy, rules, design and conduct of human studies and clinical trials. Explore how, where, when and why medical practice and biomedical enterprise intersect. Interact with academic physicians engaged in development of technology, perform clinical autopsies on failed biomedical enterprises, and develop the knowledge base needed for elective clinical experiences. Restricted to HST BEP students. 

R. Anderson

HST.212 Biomedical Enterprise Clinical Experience II

Prereq: HST.211
G (Spring) 
3-0-3 H-LEVEL Grad Credit

Provides an opportunity for students to build on the knowledge and skills developed in HST.211, as well as explore clinical aspects relevant to their respective thesis projects. Restricted to HST BEP students. 

R. Anderson

HST.220 Introduction to the Care of Patients

Prereq: Permission of instructor
G (Fall) 
2-0-2 [P/D/F] H-LEVEL Grad Credit

Can be repeated for credit

Elective subject for HST/MD candidates only. Provides an introduction to the care of patients through opportunities to observe and participate in doctor-patient interaction in an outpatient, office-based environment, and through patient-oriented seminars. Students are exposed to some of the practical realities of providing patient care. Topics include basic interviewing, issues of ethics and confidentiality, and other aspects of the doctor-patient relationship. Requirements include regular attendance, and a short paper on patient care. Enrollment limited to 15. 

W. M. Kettyle, MIT Medical Department Staff

HST.240 Translational Medicine Preceptorship

Prereq: 7.01, HST.035
G (Fall, Spring) 
0-12-0 H-LEVEL Grad Credit

Individually designed preceptorship joins together scientific research and clinical medicine. Students devote approximately half of their time to clinical experiences, and the remaining part to scholarly work in basic or clinical science. The two might run concomitantly or in series. Follow a clinical preceptor’s daily activity, including aspects of patient care, attending rounds, conferences, and seminars. Research involves formal investigation of a focused and directed issue related to selected clinical area. Final paper required. Enrollment limited to students in the GEMS Program. 

D. Sackstein, E. Edelman, R. Anderson, V. Sukhatme

HST.391 Principles of Clinical Investigation Seminar

Prereq: Permission of instructor
G (Fall, IAP, Spring) 
3-0-3 [P/D/F] H-LEVEL Grad Credit

Can be repeated for credit

Weekly seminar and case discussion series covering the essential elements of biomedical ethics, study design, statistics, pharmacoeconomics, and other subjects germane to clinical research. Enrollment limited to participants in the Clinical Investigator Training Program. 

R. Rubin, A. H. Hollenberg

HST.410 Projects in Microscale Engineering for the Life Sciences

(Same subject as 6.07J)
Prereq: None
U (Spring) 
2-4-3

A project-based introduction to manipulating and characterizing cells and biological molecules using microfabricated tools. In the first half of the term, students perform laboratory exercises designed to introduce the design, manufacture, and use of microfluidic channels; techniques for sorting and manipulating cells and biomolecules; and making quantitative measurements using optical detection and fluorescent labeling. In the second half of the term,
students work in small groups to design and test a microfluidic device to solve a real-world problem of their choosing. Includes exercises in written and oral communication and team building. Enrollment limited to 20; preference to freshmen.

D. Freeman, M. Gray, A. Aranyosi

HST.422J A Clinical Approach to the Human Brain
(Same subject as 9.22J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9
See description under subject 9.22J.
T. N. Byrne

HST.424J Diseases of the Nervous System
(Same subject as 9.24J)
Prereq: 9.01
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9
See description under subject 9.24J.
T. N. Byrne

HST.450J Biological Physics
(Same subject as 8.593J)
Prereq: 8.044 recommended but not necessary
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
4-0-8 H-LEVEL Grad Credit
See description under subject 8.593J.
G. Benedek

HST.452J Statistical Physics in Biology
(Same subject as 8.592J)
Prereq: 8.333 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 8.592J.
M. Kardar, L. Mirny

HST.457J Introduction to Molecular Simulations
(New)
(Same subject as 6.502J)
(Subject meets with 6.582J, HST.557J)
Prereq: Physics II (GIR); 18.03 or 18.06; 6.041 or 6.042; or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9
See description under subject 6.502J.
C. M. Stultz

HST.460J Statistics for Neuroscience Research
(Same subject as 9.073J)
Prereq: 9.07 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9
See description under subject 9.073J.
E. N. Brown

HST.481–HST.489 Special Subjects in Health Sciences and Technology
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Group study of subjects related to health sciences and technology not otherwise included in the curriculum. Prerequisites may vary by topic; consult faculty at time of offering.
J. Greenberg

HST.491 Reviewing Biomedical Literature
Prereq: None
U (Spring)
1-0-2
Can be repeated for credit
Assessing the value and validity of select journal articles from biomedical literature. Detailed student presentations in a standard or journal review format. Enrollment limited to 15.
D. S. Kohane

HST.500 Frontiers in (Bio)Medical Engineering and Physics
Prereq: None
G (Spring)
3-0-9
Provides a framework for mapping research topics at the intersection of medicine and engineering/physics in the Harvard-MIT community and covers the different research areas in MEMP (for example, regenerative biomedical technologies, biomedical imaging and biooptics). Lectures provide fundamental concepts and consider what's hot, and why, in each area. Training in scientific proposal writing (thesis proposals, fellowship applications, or research grant applications) through writing workshops. Topics include how to structure a novel research project, how to position research within the scientific community, how to present preliminary data effectively, and how to give and respond to peer reviews.
S. Bhatia, M. Poe

HST.505 Laboratory in Molecular and Cellular Sciences
Prereq: Biochemistry or cell biology
G (IAP)
3-4-5 H-LEVEL Grad Credit
Provides laboratory training in state-of-the-art experimental approaches and techniques in molecular and cellular sciences. Lab training is reinforced with didactic lectures which stress the theory behind these methodologies. Topics include mammalian cell culture; tissue engineering; DNA cloning; gene transfer and gene therapy; transgenic animals; protein purification and analysis; and microscopy. Emphasis on the quantitative aspects of these methodologies. Students learn how to incorporate these approaches into an interdisciplinary research strategy aimed at addressing important questions in biomedical research.
J. Shah, J. Chen, U. Demirci, J. Karp

HST.507J Advanced Computational Biology: Genomes, Networks, Evolution (New)
(Same subject as 6.878J)
(Subject meets with 6.047)
Prereq: 6.006, 6.041, and Biology (GIR); or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 6.878J.
M. Kellis

HST.508 Quantitative Genomics
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Provides a foundation in the following four areas: evolutionary and population genetics; comparative genomics; structural genomics and proteomics; and functional genomics and regulation. Each module consists of four lectures providing key background material, one lecture providing clinical correlates and one guest lecture from leaders in the field.
L. Mirny, I. Kohane, S. Sunyaev

HST.509 Computational and Functional Genomics
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Experimental functional genomics, computational prediction of gene function, and properties and models of complex biological systems. Primarily critical reading and discussion. Molecular biology, solid understanding of basic probability
HST.513 Genomic Medicine

(Subject meets with HST.512)
Prereq: HST.160 or basic genetics and molecular biology
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-6 H-LEVEL Grad Credit

Studies the use of industrialized methods of data acquisition and analysis to improve medical care. Questions addressed are: what new benefits of genomics can be anticipated in the near future in terms of new drugs and treatments? How can diagnosis and the diagnostic process be changed today? How do our prognostic abilities change? How does one manage the deluge of clinically relevant genomic data? What constitutes a genomic clinical trial? What are the useful features of alternative genomic technologies today and for the near future? What are the different kinds of genomic informational resources and databases? Are they useful and how? What are the ethical individual and corporate challenges ahead? What are the key limitations we face? Only HST students may register under HST.512, graded P/D/F. Enrollment limited.

I. Kohane

HST.514J Sensory-Neural Systems: Spatial Orientation from End Organs to Behavior and Adaptation

(Same subject as 16.430J)
Prereq: Neuroscience or systems engineering or permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Introduces sensory systems, and multi-sensory fusion using the vestibular and spatial orientation systems as a model. Topics range from end organ dynamics to neural responses, to sensory integration, to behavior, and adaptation, with particular application to balance, posture and locomotion under normal gravity and space conditions. Depending upon the background and interests of the students, advanced term project topics might include motion sickness, astronaut adaptation, artificial gravity, lunar surface locomotion, vestibulo-cardiovascular responses, vestibular neural prostheses, or other topics of interest.

L. Young, C. Oman, D. Merfeld, C. Wall

HST.515J Aerospace Biomedical and Life Support Engineering

(Same subject as 16.423J, ESD.65J)
Prereq: 16.400, 16.06, 16.060, or permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit

See description under subject 16.423J.

D. J. Newman

HST.516 Circadian Biology: From Cellular Oscillations to Sleep Regulation

Prereq: Biological sciences
G (Fall)
4-0-8 H-LEVEL Grad Credit

Properties, mechanisms, and functional roles of circadian rhythms in organisms ranging from unicells to mammals. Cellular and molecular components, regulation of gene expression and physiological functions, genetic and biochemical analyses of circadian rhythms, and neurobiology of the mammalian circadian pacemaker. Mathematics and modeling of oscillatory systems and applications to circadian rhythms. Experimental studies of human rhythms, including the sleep-wake cycle and hormone rhythms, with applications to sleep disorders. Follows Harvard FAS calendar.

J. W. Hastings, C. A. Czeisler, J. Gooley

HST.521 Biomaterials and Tissue Engineering in Medical Devices and Artificial Organs

Prereq: HST.030/031 or permission of instructor
G (Spring)
4-0-5 H-LEVEL Grad Credit

Biomaterials science (science and technology of synthetic or modified natural materials used to replace or augment tissues, organs or biological functions) and tissue engineering (tissue grafts engineered in vitro or in vivo by using cells, biomaterials and biological signals, and part of the larger field of regenerative medicine) are key areas of biomedical engineering. Covers the structure, properties and therapeutic applications of biomaterials, as well as the opportunities and scientific and technological challenges of tissue engineering. Provides an integrated and highly multidisciplinary biological-engineering approach in a mixed academic/corporate context and probes mechanisms and methods of evaluation of tissue/biomaterials and patient/device interactions.Assesses current outcomes, current challenges and cutting edge technological solutions to medical problems. Additional topics include key biological concepts; biofunctional/bioactive materials, drug delivery, and pertinent advances in nanotechnology; technical issues in design, development, fabrication and clinical evaluation; novel research directions and applications of materials to medicine; and ethical, economic and regulatory considerations.

F. J. Schoen, A. Khademhosseini

HST.522J Biomaterials: Tissue Interactions

(Same subject as 2.79J, 3.96J, 20.441J)
Prereq: Chemistry (GIR); 2.005 or 5.60; Biology (GIR)
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 20.441J.

I. V. Yannas, M. Specter

HST.523J Cell-Matrix Mechanics

(Same subject as 2.785J, 3.97J, 20.411J)
Prereq: 2.005 or 5.60; Biology (GIR); Chemistry (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 2.785J.

I. V. Yannas, M. Specter
HST.524] Design of Medical Devices and Implants
(Same subject as 2.782J, 3.961J, 20.451J)
Prereq: 2.79J or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.782J.
I. V. Yannas, M. Spector

HST.525] Tumor Pathophysiology and Transport Phenomena: A Systems Biology Approach
(Same subject as 10.548J)
Prereq: 18.03; 10.301
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
2-0-4 H-LEVEL Grad Credit
Tumor pathophysiology plays a central role in the growth, invasion, metastasis and treatment of solid tumors. Principles of transport phenomena are applied to develop a systems level, quantitative understanding of angiogenesis, blood flow and microcirculation, metabolism and microenvironment, transport and binding of small and large molecules, movement of cancer and immune cells, metastatic process, and treatment response.
R. K. Jain

HST.527 Blood Vessels and Endothelial Phenotypes in Health and Disease
Prereq: Intro biology and/or physiology, biochemistry or molecular biology or permission of instructor
G (Spring)
2-0-4 [P/D/F] H-LEVEL Grad Credit
Overview of the endothelium as a model system for understanding biological complexity in health and disease. Emphasis placed on: mechanisms of endothelial cell heterogeneity, including genetic and microenvironmental determinants; the role of endothelial cell trafficking, hemostasis, barrier function, antigen presentation and vasomotor tone; and the role of endothelial cell dysfunction in disease, including tumors, sickle cell disease, pulmonary hypertension, veno-occlusive disease of the liver, thrombotic microangiopathies and xenotransplantation. Additional topics covered include novel proteomic and genomic strategies for mapping endothelial cell phenotypes, evolutionary (Darwinian) principles, and complexity theory.
W. Aird, G. Garcia-Cardena

HST.531 Medical Physics of Proton Radiation Therapy
Prereq: None
G (Spring)
2-0-4
Acceleration of protons for radiation therapy; introduction into advanced techniques such as laser acceleration and dielectric wall acceleration. Topics include the interactions of protons with the patient, Monte Carlo simulation, and dose calculation methods; biological aspects of proton therapy, relative biological effectiveness (RBE), and the role of contaminating neutrons; treatment planning and treatment optimization methods, and intensity-modulated proton therapy (IMPT); the effect of organ motion and its compensation by use of image-guided treatment techniques; general dosimetry and advanced in-vivo dosimetry methods, including PET/CT and prompt gamma measurements. Outlook into therapy with heavier ions. Includes practical demonstrations at the Proton Therapy Center of the Massachusetts General Hospital.
T. Bortfeld

HST.532 Hyperthermia and Clinical Applications of Bioheat Transfer
Prereq: None
G (Spring)
3-0-9
H. F. Bowman

HST.535 Principles and Practice of Tissue Engineering
Prereq: None
G (Fall)
2-0-6
The principles and practice of tissue engineering (and regenerative medicine) are taught by leaders in the field. Topics include the principles underlying strategies for employing selected exogenous cells, biomaterial scaffolds, soluble regulators or their genes, and mechanical loading for the regeneration of tissues and organs in vitro and in vivo. Differentiated cell types and stem cells are compared and contrasted for this application, as are natural and synthetic scaffolds. The rationale for employing selected growth factors is covered and the methods for incorporating their genes into the scaffolds are examined. Discussion addresses the influence of environmental factors including mechanical loading and culture conditions. Methods for fabricating tissue-engineered products and devices for implantation are taught. Examples of procedures currently employed clinically are analyzed as case studies. All sessions are webcast to the world and archived for open access review at any time.
M. Spector

HST.540] Human Physiology
(Same subject as 7.20J)
Prereq: 7.05
U (Fall)
5-0-7
See description under subject 7.20J.
M. Krieger, D. Sabatini

HST.541] Cellular Biophysics
(Same subject as 2.794J, 6.521J, 20.470J)
(Same subject as 2.792J, 6.021J, 20.370J)
Prereq: Physics II (GIR); 18.03; 2.005, 6.002, 6.003, 6.071, 10.301, 20.110, or permission of instructor
G (Fall)
5-2-5 H-LEVEL Grad Credit
Meets with undergraduate subject 6.021J. Requires the completion of more advanced home problems and/or an additional project.
D. M. Freeman, J. Han

HST.542] Quantitative Systems Physiology
(Same subject as 2.792J, 6.022J, 20.371J)
(Same subject as 2.796J, 6.522J, 20.471J)
Prereq: Physics II (GIR), 18.03, or permission of instructor
U (Spring)
4-2-6
See description under subject 6.022J.
R. G. Mark, C. M. Stultz

HST.543 Cardiac Biophysics
Prereq: 18.03, 6.002, 6.013, and 6.021
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
A quantitative exploration of cardiac impulse propagation and conduction abnormalities. Membrane ion channels, the cardiac action potential, biophysical principles of propagation, propagation in cellular networks, mechanisms of slow conduction and conduction block, and arrhythmias. Relevant clinical trials data are
Use of MRI and high-resolution CT for imaging of fracture mechanics of bone tissue, Finite Elements. Special topics include clinical orthopedics, soft tissues (cartilage, ligament, muscle), and skeletal systems. Emphasis on the mechanics of orthopedic science. Review of anatomy, kinesiology, and solid mechanics for the musculoskeletal system. Introduction to biomechanics as applied to orthopedic science. Overview of anatomy, kinesiology, and solid mechanics for the musculoskeletal system. Introduction to biomechanics as applied to orthopedic science. Review of anatomy, kinesiology, and solid mechanics for the musculoskeletal system. Emphasis on applications of imaging research. Final project consists of student groups writing mock grant applications for biomedical imaging research project, modeled after an exploratory National Institutes of Health (NIH) grant application.

S. Stufflebeam, D. Boas, F.-H. Lin

HST.565 Molecular Imaging using SPECT and PET-CT (New)
Prereq: None
G (Spring)
3-0-9

Covers the physical and instrumentation basics of positron emission tomography (PET) and single photon emission tomography (SPECT). Topics include atomic and nuclear structure, charged particles and photon interactions, radiation detectors, pulse height spectrometry, detection and measurement, counting systems, survey meters, nuclear counting statistics, modes of radioactive decay, gamma cameras, and collimators. Presents physical factors affecting image quality, such as Compton scatter, random coincidences, photoelectric absorption, deadtime, etc., as well as different approaches to compensate for them. Discusses clinical applications of PET and includes a practical demonstration of SPECT and PET-CT imaging at the Massachusetts General Hospital.

G. El Fakhri

HST.569 Biomedical Optics
Prereq: Calculus
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
4-0-8 H-LEVEL Grad Credit

Introduction to physics and engineering of optical technologies and their applications in medicine and biology. Propagation of light in tissue, bright field, dark field, phase contrast, DIC, fluorescence, Raman, confocal, two-photon, low-coherence, spectral microscopy, and speckle. Current trends in microscopy and optical imaging. Subject is appropriate for upper level undergraduates and graduate students in life sciences as well as engineering. Subject consists of lectures, seminars and occasional guest lectures. Grading based on mid-term and final report. Report analyzes a specific technological need in medicine or biology and proposes a solution. The opportunity to pursue the implementation of the solution as a project in the following term is available.

B. E. Bouma, G. J. Tearney, J. F. de Boer
HST.572 Future Medical Technologies
Prereq: Permission of instructor
G (Spring)
2-0-4 [P/D/F]

Subject helps medical and graduate students to develop an understanding of the limitations of current medical technology and the process of creating and transferring new medical technology from research into actual use (commercialization). Topics include pharmaceuticals, drug delivery, and medical devices. In a seminar setting, students interact with biomedical scientists, engineers, and entrepreneurs directly involved in creating new companies based on future technologies. Students may find this subject helpful in evaluating possible theses. Open to advanced undergraduates with permission of instructor.

J. C. Weaver

HST.575J Bioelectronics Project Laboratory
(Same subject as 6.121J)
Prereq: 6.002 or 6.071
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
2-8-2 Institute LAB
See description under subject 6.121J.
D. M. Freeman, M. F. Yanik

HST.576J Topics in Neural Signal Processing
(Same subject as 9.272J)
Prereq: None
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9
See description under subject 9.272J.
E. N. Brown

HST.580J Data Acquisition and Image Reconstruction in MRI
(Same subject as 6.556J)
Prereq: 6.011
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.556J.
E. Adalsteinsson

HST.582J Biomedical Signal and Image Processing
(Same subject as 6.555J, 16.456J)
Prereq: 6.003, 2.004, 16.004, or 18.085
G (Spring)
3-6-3 H-LEVEL Grad Credit

Fundamentals of digital signal processing with particular emphasis on problems in biomedical research and clinical medicine. Basic principles and algorithms for data acquisition, imaging, filtering, and feature extraction. Laboratory projects provide practical experience in processing physiological data, with examples from cardiology, speech processing, and medical imaging.

J. Greenberg, E. Adalsteinsson, W. Wells, G. Clifford

HST.583 Functional Magnetic Resonance Imaging: Data Acquisition and Analysis
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
Units arranged H-LEVEL Grad Credit

Provides information relevant to the conduct and interpretation of human brain mapping studies. In-depth coverage of the physics of image formation, mechanisms of image contrast, and the physiological basis for image signals. Parenchymal and cerebrovascular neuroanatomy and application of sophisticated structural analysis algorithms for segmentation and registration of functional data discussed. Additional topics include fMRI experimental design including block design, event related and exploratory data analysis methods, and building and applying statistical models for fMRI data. Human subject issues including informed consent, institutional review board requirements and safety in the high field environment are presented. Twice weekly lectures and weekly laboratory and discussion sessions. Laboratory will include fMRI data acquisition sessions and data analysis workshops. Assignments include reading of both textbook chapters and primary literature as well as fMRI data analysis in the laboratory. Probability, linear algebra, differential equations, and introductory or college-level subjects in neurobiology, physiology, and physics required.


HST.584J Magnetic Resonance Analytic, Biochemical, and Imaging Techniques
(Same subject as 22.561J)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-12 H-LEVEL Grad Credit

Introduction to basic NMR theory. Examples of biochemical data obtained using NMR summarized along with other related experiments. Detailed study of NMR imaging techniques includes discussions of basic cross-sectional image reconstruction, image contrast, flow and real-time imaging, and hardware design considerations. Exposure to laboratory NMR spectroscopic and imaging equipment included.

B. R. Rosen

HST.586–589 Special Subjects in Medical Engineering and Medical Physics
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Opportunity for group study of advanced subjects related to the Medical Engineering and Medical Physics Program not otherwise included in the curriculum. Offerings are initiated by MEMP faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

J. Greenberg

HST.590 Biomedical Engineering Seminar Series
Prereq: None
G (Fall, Spring)
1-0-0 [P/D/F]
Can be repeated for credit

Seminars focused on the development of professional skills. Each term focuses on a different topic, resulting in a repeating cycle that covers medical ethics, responsible conduct of research, written and oral technical communication, and translational issues. Includes guest lectures, case studies, interactive small group discussions, and role-playing simulations.

Fall: HST Faculty
Spring: HST Faculty

HST.591 Biomedical Engineering Research Seminar
Prereq: None
G (Fall, Spring)
2-0-0 H-LEVEL Grad Credit
Can be repeated for credit

Development of professional speaking skills in the communication of research progress. Students present their research, emphasizing clear statement of the goals, significance, and current status of their work. Confidential, written feedback given by each member of the audience. Required of all students affiliated with the HST Biomedical Engineering Center.

E. R. Edelman, J. C. Weaver
HST.592 Seminar in Computational Biology
Prereq: Background in molecular biology, computer science and bioinformatics
G (Fall) 2-0-4
Can be repeated for credit
L. Mimy

HST.594 Translational Medicine Seminars
Prereq: None
G (Fall, Spring) 1-0-0 [P/D/F]
Can be repeated for credit
Speakers involved in the translation of basic medically relevant modern biology (molecular genetics, cell biology, genomics, proteomics) into applications for the diagnosis or treatment of disease discuss the process, successes and challenges. Examples from different areas of medicine illustrate topics covered: what is translational research; why it is often conducted as a bidirectional process; the difficulties in extrapolating preclinical data to humans; issues related to patient enrollment, compliance and rights; study design and protocol management; funding; availability of suitable grade therapeutic reagents. The multidisciplinary nature of the enterprise are highlighted, including the management of industry and academic center relationships. Enrollment limited to 25; preference to GEMS, then HMS Leder and MIT.
R. Sackstein

HST.598 Special Topics in Health Sciences and Technology
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
For undergraduates desiring to carry on substantial projects of their own choosing in biomedical sciences or engineering. Work may be of experi-
mental, theoretical, or design nature. A project proposal is required at time of registration.
Consult J. Greenberg

HST.599 Research in Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
For students conducting research in HST, in cases where the assigned research is approved for academic credit by the department. Hours arranged with research supervisor.
Consult HST Faculty

HST.710J Speech Communication
(Same subject as 6.541J, 24.968J)
Prereq: Permission of instructor
G (Spring) 3-1-8 H-LEVEL Grad Credit
See description under subject 6.541J.
L. D. Braida, R. E. Hillman, S. Shattuck-Hufnagel

HST.712J Laboratory on the Physiology, Acoustics, and Perception of Speech
(Same subject as 6.542J, 24.966J)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall) Acad Year 2010–2011: Not offered
2-2-8 H-LEVEL Grad Credit
See description under subject 6.542J.
L. D. Braida, S. Shattuck-Hufnagel

HST.714J Acoustics of Speech and Hearing
(Same subject as 6.551J)
Prereq: 8.03, 6.003; or permission of instructor
G (Fall) 4-1-7 H-LEVEL Grad Credit
See description under subject 6.551J.
L. D. Braida, S. S. Ghosh, J. J. Rosowski, C. A. Shera

HST.716J Signal Processing by the Auditory System: Perception
(Same subject as 6.552J)
Prereq: 6.003; 6.041 or 6.431; or permission of instructor
Acad Year 2009–2010: Not offered Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.552J.
L. D. Braida

HST.718 Anatomy of Speech and Hearing
Prereq: Biology (GIR), permission of instructor
G (IAP) 2-2-2 H-LEVEL Grad Credit
Study of the human body and brain, focusing on structures of the head and neck involved in speech and hearing. General organization of the nervous system and control of the peripheral structures. Involves dissection of a human cadaver and examination of brain specimens. Preference to students with some biology background and order of seniority of class.
B. C. Fullerton

HST.720 Physiology of the Ear
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered Acad Year 2010–2011: G (Fall) 4-0-8 H-LEVEL Grad Credit
Physical and physiological mechanisms underlying the transduction and analysis of acoustic signals in the auditory periphery. Topics include the acoustics, mechanics, and hydrodynamics of sound transmission; the biophysical basis for cochlear amplification; the production of otoacoustic emissions; the physiology of hair-cell transduction and synaptic transmission; efferent feedback control; the analysis and coding of simple and complex sounds by the inner ear; and the physiological bases for hearing disorders. Based primarily on reading and discussions of original research literature.
J. J. Guinan, J. J. Rosowski, C. A. Shera

HST.721 The Peripheral Auditory System
Prereq: Permission of instructor
G (Fall) 3-1-8 H-LEVEL Grad Credit
Experimental approaches to the study of hearing and deafness, presented through lectures, laboratory exercises and discussions of the primary literature on the auditory periphery. Topics include inner ear development; functional anatomy of the inner ear; cochlear mechanics and micromechanics; mechanoelectric transduction by hair cells; outer hair cells' electromotility and the cochlear amplifier; otoacoustic emissions, synaptic transmission; stimulus coding in auditory nerve responses; efferent control of cochlear function; damage and repair of hair-cell organs; and sensorineural hearing loss.
M. C. Liberman, J. C. Adams, R. A. Eatock
HST.722| Brain Mechanisms for Hearing and Speech
(See subject as 9.044J)
Prereq: HST.723 or permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
4-0-8 H-LEVEL Grad Credit
An advanced subject covering anatomical, physiological, behavioral, and computational studies of the central nervous system relevant to speech and hearing. Students learn primarily by discussions of scientific papers on topics of current interest. Recent topics include neural circuits in the auditory brainstem, organization and processing in the auditory cortex, auditory reflexes and descending systems, functional imaging of the human auditory system, quantitative methods for relating neural responses to behavior, speech motor control, and cortical representation of language.
M. C. Brown, B. Delgutte, F. Genther, J. Melcher

HST.723| Neural Coding and Perception of Sound
(See subject as 9.285J)
Prereq: Permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit
Neural structures and mechanisms mediating the detection, localization, and recognition of sounds. Discussion of how acoustic signals are coded by auditory neurons, the impact of these codes on behavioral performance, and the circuitry and cellular mechanisms underlying signal transformations. Topics include temporal coding, neural maps and feature detectors, learning and plasticity, and feedback control. General principles are conveyed by theme discussions of auditory masking, sound localization, musical pitch, cochlear implants, and auditory scene analysis.
B. Delgutte, M. C. Brown, J. J. Guinan, J. Melcher

HST.724| Clinical Aspects of Speech and Hearing
Prereq: HST.714J, HST.718, HST.721
G (Spring)
5-5-2 H-LEVEL Grad Credit
Clinical approach to speech and hearing disorders as practiced by physicians, audiologists, speech clinicians, rehabilitation specialists, pathologists, and bioengineers. Includes observation of patient care in the clinic and operating room; laboratory experience in audiology, voice and speech evaluation, evaluation of balance disorders; lectures and discussion groups.
J. B. Nadol

HST.725| Music Perception and Cognition
Prereq: HST.723 or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
4-0-8 H-LEVEL Grad Credit
Survey of perceptual and cognitive aspects of the psychology of music, with special emphasis on underlying neurocomputational representations and mechanisms. Systematically explores basic dimensions of hearing (pitch, timbre, consonance, loudness) and the time sense (duration, temporal pattern) that form our perception of tonal quality, melody, harmony, meter, and rhythm in music. Examines mechanisms responsible for separation of multiple voices/instruments (polyphony), and for melodic and rhythmic grouping of events (musical phrase structure). Special topics include comparative, evolutionary, and developmental psychology of music; biological vs. cultural influences; Gestaltist, associationist, and schema-based theories; music vs. speech perception; music vs. language cognition; music and cortical function, music therapy, and neural basis of music performance.
P. Cariani

HST.726| Cognitive Neuroscience of Language and Music (New)
Prereq: None
G (Spring)
3-0-9
Multi-disciplinary course on language and music covering basic principles and current research in cognitive psychology, psychoacoustics, neuroanatomy, neurophysiology, neurology, and neuroradiology. Emphasis on the functional organization of auditory cortex and distributed cortical and subcortical structures mediating auditory cognition. Topics include: classical neurobehaviral syndromes caused by stroke and other diseases afflicting cerebral cortex (e.g., auditory agnosia, aphasia, dyslexia); fMRI, PET, and ERP studies of phonological, syntactic, and semantic processing by normal adults; neural coding of vocal communication signals in anthropoids and birds. Examines how perceptual and cognitive functions map onto cortical gyri in the left and right cerebral hemispheres of the human brain, and the pathophysiology of diseases that derange these functions. Suggests experimental methodologies that students can cultivate and apply to basic and clinical research in the future.
M. Tramo, A. Carabasso, B. Fullerton, D. Gow, M. Hauser, J. Melcher, B. Olveczsky

HST.727| The Lexicon and Its Features
(See subject as 6.543J, 9.587J, 24.941J)
Prereq: 24.901 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 24.941J.
D. Gow, D. Steriade, S. Shottuck-Hufnagel

HST.728| Automatic Speech Recognition
(See subject as 6.345J)
Prereq: 6.003, 6.041
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-1-8 H-LEVEL Grad Credit
See description under subject 6.345J.
V. W. Zue, J. R. Glass

HST.729| Advanced Speech and Audio Processing
Prereq: 6.003
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduction to advanced speech and audio processing, including both mathematical models and practical applications thereof. Time-frequency analysis, synthesis, modification, and coding of information-carrying natural sound signals; relevant aspects of acoustics and auditory perception; fundamental contemporary applications and methodologies. Students are required to prepare a substantial term project at a level on par with current research in the field. Follows Harvard FAS schedule.
P. J. Wolfe

HST.730| Molecular Biology of the Auditory System
Prereq: Biology (GIR)
G (Fall)
3-0-9 H-LEVEL Grad Credit
Advanced subject in the molecular biology of the auditory system. Focuses on molecular approaches to function and dysfunction of the cochlea, based on readings and discussion of research literature. Lectures are delivered by course directors and local experts in the field. Laboratory component includes molecular biology techniques with emphasis on auditory gene identification.
A. Edge
HST.750 Modeling Issues in Hearing and Speech
Prereq: HST.714J/6.551J and HST.721
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Explores the theory and practice of scientific modeling in the context of auditory and speech biophysics. Based on seminar-style discussions of the research literature, subject draws on examples from hearing and speech (cochlear and vocal-fold mechanics) and explores general, meta-theoretical issues that transcend the particular subject matter. Examples include: What is a model? What is the process of model building? What are the different approaches to modeling? What is the relationship between theory and experiment? How are models tested? What constitutes a good model?
C. A. Shera, J. R. Melcher

HST.771–HST.779 Research in the Speech and Hearing Sciences
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Research on topics in theoretical, experimental, or clinical aspects of Speech and Hearing Sciences arranged on an individual basis with a research supervisor. At the time of registration, a project proposal endorsed by the supervisor is required. At the end of the term, a concise written progress report along with a brief written evaluation by the supervisor must be submitted.
L. D. Braida

HST.780–789 Special Subjects in the Speech and Hearing Sciences
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for group study of advanced subjects related to the Speech and Hearing Sciences not otherwise included in the curriculum. Offerings initiated by members of the SHBT faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
L. D. Braida

HST.790 Research Approaches to Speech and Hearing
Prereq: 6.021J, 7.20 or 9.00
G (Spring)
6-0-6 H-LEVEL Grad Credit
Approaches and techniques of speech and hearing research are analyzed through the preparation of a mock thesis proposal. Professional responsibilities of scientists and issues such as standards for conducting research, integrity in science, and criteria for human and animal studies examined in detail. A written mock thesis proposal required.
D. K. Eddington

HST.791 Speech and Hearing Laboratory Visits
Prereq: None
G (Fall, Spring)
0-1-0 [P/D/F]
Can be repeated for credit
A weekly meeting to acquaint first-year students in the Speech and Hearing Bioscience and Technology Program with research opportunities. Meetings at different laboratories are hosted by faculty members of the program. These informal, introductory visits are designed to acquaint students with the kinds of work done in each laboratory.
L. D. Braida

HST.901J Health Economics (Same subject as 14.21J)
Prereq: 14.01
U (Fall)
3-0-9 HASS
See description under subject 14.21J.
J. E. Harris

HST.903J Health Economics Seminar (Same subject as 14.286J)
Prereq: 14.04, permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 14.286J.
J. E. Harris

HST.905 Introduction to Health Care Management
Prereq: None
G (Spring)
2-0-4
Introduction to the academic disciplines of business management with illustration from examples in various medical care settings. Topics include economics of health care; evolving role of physicians and other medical professionals; ethics of business decisions in a clinical context; underlying concepts in financial, marketing, and operations management in health institutions; and the management of risk in health-related enterprise. Presentations by carefully selected multidisciplinary faculty group from the Harvard and MIT communities. Student projects address current issues occasioned by the rapidly changing health care environment. Meets at Harvard Medical School. Enrollment limited to graduate and medical students.
S. Finkelstein, P. L. Slavin

HST.906 Role of Physicians and Scientists in the Business World
Prereq: Permission of instructor
G (Spring)
2-0-0 [P/D/F]
A pragmatic, experience-based subject for MDs and PhDs surveying career opportunities in industry, including case studies of pharmaceutical, medical device and biotech companies. Covers venture capital processes, company formation and capitalization, innovative technology sources, tech transfer process at universities and medical schools, startup operational issues, role of VCs and board members, execution time frames, liquidity process, IPOs, mergers and acquisitions, and payout prospects for founders and inventors. A high tech career-planning guide from over twenty years of entrepreneurship VC practice in medical and biotech companies is shared.
J. M. Gil, S. Schachter

HST.916J Case Studies and Strategies in Drug Discovery and Development (Same subject as 7.549J, 15.137J, 20.486J)
Prereq: Permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit
See description under subject 20.486J.
S. R. Tannenbaum, A. J. Sinskey, E. Berndt

HST.918J Economics of the Health Care Industries (Same subject as 15.141J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 15.141J.
E. R. Berndt

HST.920J Principles and Practice of Drug Development (Same subject as 7.547J, 10.547J, 15.136J, ESD.691J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject 15.136J.
T. J. Allen, C. L. Cooney, S. N. Finkelstein, R. H. Rubin, A. J. Sinskey
HST.922 Information Technology in the Health Care System of the Future
(Subject meets with HST.921)
Prereq: None
G (Spring)
2-0-7

Innovative, trans-faculty subject teaches how information technologies are reshaping and redefining the health care marketplace through improved economies of scale, greater technical efficiencies in the delivery of care to patients, advanced tools for patient education and self-care, network integrated decision support tools for clinicians, and the emergence of e-commerce in health care. Students ordinarily also register for HST.923 or HST.924, the lab component of this subject. Undergraduates require permission of instructor. Only HST students may register under HST.921, graded P/D/F.
S. E. Locke, B. P. Bergeron, J. Blander, D. Z. Sands, J. A. Carter

HST.924 Information Technology in the Health Care System of the Future (Laboratory)
(Subject meets with HST.923)
Prereq: None
G (Spring)
0-3-0

Student tutorial provides an opportunity for interactive discussion covering emerging information technologies (IT) used in healthcare. Practicum: HMS and MIT graduate students in medicine, business, law, education, engineering, computer science, public health, and government collaborate in interdisciplinary teams to design an innovative IT application. Student projects presented during the final class.
Students ordinarily also register for HST.921 or HST.922, the lecture component of the subject. Undergraduates require permission of instructor. Only HST students may register under HST.923, graded P/D/F.
S. E. Locke, B. P. Bergeron, J. Blander, D. Z. Sands, J. A. Carter

HST.932 The Legal Framework of Biomedical Enterprise
(Same subject as 15.126J)
Prereq: Permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
2-0-3

Designed to prepare managers, physicians, and research scientists to exercise good judgment and leadership when confronting key law-sensitive issues arising in the commercialization of new biomedical technologies. After covering some legal fundamentals, students follow a biomedical enterprise through a typical life cycle. Topics include linkages between university-based research centers and proprietary enterprises, establishing a new venture and obtaining early financing, protection of intellectual property, the FDA process, reimbursement and coverage, liability risks, tapping public securities markets, and corporate partnering and private equity. Special attention is given to the legal, ethical and professional standards that bear upon health care.
J. Akula

HST.934 Introduction to Global Medicine: Bioscience, Technologies, Disparities, Strategies
(Same subject as STS.449J)
Prereq: None
G (Spring)
2-0-1 [P/D/F]

Exploration of basic themes in social medicine via a specific examination of issues in global medicine. The course takes as its challenge to understand new paradigms for global health that focus on providing complex medical services to treat complicated health conditions (e.g. multi-drug resistant TB, HIV/AIDS, and mental health problems) in low resource settings. Special attention given to the development of new technologies or adapting existing technologies in ways that enable new solutions to global health problems, as well as overcoming barriers to translation of medical technologies for use in settings of great need. Addresses classic themes of social inequalities and health disparities, and issues such as patenting and the development and delivery of pharmaceuticals or other biotechnologies in international context. Presentations by Harvard faculty involved in global health, basic or clinical research with a global reach, or medical humanitarian activities, in addition to class discussion.
B. J. Good, M. D. Good, M. M. Fischer, D. Jones

HST.937] X PRIZE Workshop: Grand Challenges in Health Care
(Same subject as SP.792J, ESD.173J)
Prereq: Permission of instructor
G (Spring)
3-0-6

See description under subject ESD.173J.
E. Wagner, D. Newman, F. Murray, K. Zolot, J. Shames, C. Cooney

HST.938] Designing and Sustaining Technology Innovation for Global Health Practice
(Same subject as 15.127J)
Prereq: None
G (Spring)
Units arranged

Course trains students to think and act like global health leaders and entrepreneurs. Looks at the business of running a social venture and how to plan and provide access to life-saving medicines and essential services in international and domestic settings. Considers specific case studies for influential and leading edge technologies for health services delivery, as well as human resources, and pharmaceutical and diagnostic design in resource-poor settings. Features lectures and skills-based tutorial sessions led by industry, foundation, and academic leaders. Lectures provide the foundation for a design project that may involve creation of a market or business plan, product design specification, or research study. Enrollment limited to 24.
U. Demirci, J. Blander

HST.940] Bioinformatics: Principles, Methods and Applications
(Same subject as 10.555J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 10.555J.
Gr. Stephanopoulos, I. Rigoutsos

HST.947 Medical Artificial Intelligence
(Subject meets with 6.034)
Prereq: 6.001
G (Spring)
5-3-4 H-LEVEL Grad Credit

An intensive introduction to artificial intelligence and its applications to problems of medical diagnosis, therapy selection, and monitoring and learning from databases. Subject meets with lectures and recitations of 6.034 in the spring term only. Its material is supplemented by additional readings and discussion sessions. Students are responsible for completing all homework assignments and for additional problems and/or papers. Subject is available for credit only to graduate students in HST.
P. H. Winston, T. Lozano-Perez
HST.949 Computational Evolutionary Biology
(Same subject as 6.877J)
(Subject meets with 6.048)
Prereq: 6.046J, 6.047, 7.36, 6.807, or HST.508;
or permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-3-6 H-LEVEL Grad Credit
See description under subject 6.877J.
R. C. Berwick

HST.950 Biomedical Computing
(Same subject as 6.872J)
Prereq: 6.034
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.872J.
P. Szolovits, I. Kohane, L. Ohno-Machado

HST.951 Biomedical Decision Support
(Same subject as 6.873J)
Prereq: 6.034 or HST.947; programming skills or
permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

HST.956 Data, Medicine, and Ethics
Prereq: None
G (IAP)
1-0-3 [P/D/F]

HST.959 Research Topics in Biomedical Informatics
Prereq: None
G (Fall, Spring, Summer)

HST.960 At the Limits of Medicine: Philosophy, Religion, Literature
Prereq: None
G (IAP)
1-0-3 [P/D/F]

HST.971 Strategic Decision Making in the Biomedical Business
(Same subject as 15.363J)
Prereq: None
G (Spring)
3-0-6
See description under subject 15.363J.
F. Murray

HST.973 Evaluating a Biomedical Business Concept
(Same subject as 15.124J)
Prereq: HST.971
G (Spring)
1-0-2 H-LEVEL Grad Credit

HST.975 Clinical Trials in Biomedical Enterprise
(Same subject as 15.121J)
Prereq: None
G (Fall)
2-0-4

Critical analysis of new biomedical business ideas. Principals of early stage companies, or inventors, present their ideas and provide background material including scientific papers and patents. Teams of students evaluate each business idea. Students develop a series of analyses concerning the critical issues that each business idea would face. Issues may include efficacy of a technology, intellectual property protection, market opportunity, regulatory and reimbursement hurdles, competitive threats and potential return on investment. Students are encouraged to review scientific, clinical, patent and marketing literature as well as interview key individuals including principals, inventors, potential customers and competitors. Analyses focus on the issues most critical for the success of the proposed business concept.
R. J. Cohen, T. Dagi, C. Berke, E. Cannon

HST.971 Evaluating a Biomedical Business Concept
(Same subject as 15.124J)
Prereq: HST.971
G (Spring)
1-0-2 H-LEVEL Grad Credit

Critical analysis of new biomedical business ideas. Principals of early stage companies, or inventors, present their ideas and provide background material including scientific papers and patents. Teams of students evaluate each business idea. Students develop a series of analyses concerning the critical issues that each business idea would face. Issues may include efficacy of a technology, intellectual property protection, market opportunity, regulatory and reimbursement hurdles, competitive threats and potential return on investment. Students are encouraged to review scientific, clinical, patent and marketing literature as well as interview key individuals including principals, inventors, potential customers and competitors. Analyses focus on the issues most critical for the success of the proposed business concept.
R. J. Cohen, T. Dagi, C. Berke, E. Cannon

HST.975 Clinical Trials in Biomedical Enterprise
(Same subject as 15.121J)
Prereq: None
G (Fall)
2-0-4

Clinical trials have become one of the leading barriers to success in the introduction of new products and services for the healthcare industry. Subject enables healthcare managers to ask the important questions surrounding a decision to pursue a clinical trial. Deciding to participate in a clinical trial can sometimes result in expensive, long-term corporate commitments, which can have a significant impact on the company’s success or failure, particularly in the case of smaller companies. Subject explores issues related to determining whether a clinical trial is needed to significantly further the important goals of the company. Topics include the design, implementation, analysis and presentation of clinical trials. Case scenarios are presented by professionals in the field, and students are asked to develop their own outline plan and
clinical trial study plan from the sample cases provided. Enrollment limited.

H. Golub

**HST.977j Critical Reading and Technical Assessment of Biomedical Information**
(Same subject as 15.122j)
Prereq: SB degree in Biological Science or permission of instructor
G (Spring; first half of term)
1-0-2 H-LEVEL Grad Credit

Gain experience in critical reading of scientific literature with an emphasis on analyzing clinical controversies and emerging technologies in subject areas that have been or could become sources of entrepreneurial activity. Students required to analyze a variety of topics in the scientific literature, including screening for and cost-effectiveness of early detection of cancer, therapeutic opportunities on oncology, evaluation of immunotoxins and antibody therapies, and new prospects for the treatment of autoimmune disorders. To support the discussion of these topics, outside experts may be invited to participate as facilitators.

S. Lapidus, S. Sengupta

**HST.979j Dynamics of Biomedical Technologies**
(Same subject as 15.123j)
Prereq: None
G (Fall, Spring)
2-0-1 [P/D/F]
Can be repeated for credit

Designed to help students develop skills for conducting and reporting thesis research. Teaches students to identify research problems in the area of biomedical enterprise, develop testable hypotheses regarding such problems, design strategies to test the hypotheses, and when applicable, report progress in implementing these strategies. Limited to students enrolled in the Biomedical Enterprise Program.

R. Cohen, T. Dagi, C. Berke

**HST.986–HST.989 Special Subjects in Biomedical Enterprise**
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Opportunity for group study of advanced subjects relating to biomedical enterprise not otherwise included in the curriculum. Offerings are initiated by HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic. Consult faculty at time of offering.

J. Greenberg

**HST.ThG Graduate Thesis**
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Program of research leading to the writing of a PhD or ScD thesis or an HST SM thesis; to be arranged by the student and an appropriate MIT faculty advisor.

M. L. Gray

**HST.UR Undergraduate Research in Health Sciences and Technology**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

**HST.URG Undergraduate Research in Health Sciences and Technology**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Extended participation in the work of a faculty member or research group. Research is arranged by mutual agreement between the student and a member of the faculty of the Harvard-MIT Division of Health Sciences and Technology, and may continue over several terms. Registration requires submission of a written proposal, signed by the faculty supervisor. A summary report must be submitted at the end of each term.

H. F. Bowman
### UNDERGRADUATE SUBJECTS

**MAS.110 Fundamentals of Computational Media Design**  
Prereq: None  
U (Fall)  
3-3-6 HASS, CI-H  
History of modern art and design from the perspective of the technologist. Exploration of visual analysis, typography, and technologies for audio/visual expression. Limited enrollment.  
*V. M. Bove, Jr.*

**MAS.111 Introduction to Doing Research in Media Arts and Sciences**  
Prereq: None  
U (Spring)  
1-4-1 [P/D/F]  
Intended for students pursuing research projects at the Media Laboratory. Topics include Media Lab research areas; documenting research progress; ethical issues in research; patents, copyrights, intellectual property; and giving oral, written, and online presentations of results. A final oral presentation is required. Enrollment limited with preference given to students in the Media Arts and Sciences freshman program.  
*V. M. Bove, Jr.*

**MAS.131 Computational Camera and Photography (New)**  
(Subject meets with MAS.531)  
Prereq: Permission of instructor  
U (Fall)  
3-0-9  
Covers the complete pipeline of computational cameras that attempt to digitally capture the essence of visual information by exploiting the synergistic combination of task-specific optics, illumination, sensors, and processing. Students discuss and use thermal, multi-spectral, high-speed and 3-D range-sensing cameras, as well as camera arrays. Presents opportunities in scientific and medical imaging, and mobile phone-based photography. Also covers cameras for human computer interaction (HCI) and sensors that mimic animal eyes. Intended for students with interest in algorithmic and technical aspects of imaging and photography. Students taking graduate version complete additional assignments.  
*R. Raskar*

**MAS.132 Camera Culture (New)**  
(Subject meets with MAS.532)  
Prereq: Permission of instructor  
U (Spring)  
2-0-7  
Surveys the landscape of imaging techniques and develops skills for conducting imaging research. Reviews technical and social aspects of the evolving camera culture and considers its role in transforming social interactions, reshaping businesses, and influencing communities worldwide. Explores innovative protocols for sharing and consumption of visual media, as well as novel hardware and software tools based on advanced lenses, digital illumination, modern sensors, and emerging image-analysis algorithms. Students taking graduate version complete additional assignments.  
*R. Raskar*

**MAS.160 Signals, Systems, and Information for Media Technology**  
(Subject meets with MAS.510)  
Prereq: Calculus II (GIR)  
Acad Year 2009–2010: U (Fall)  
Acad Year 2010–2011: Not offered  
4-0-8  
Fundamentals of signals and information theory with emphasis on modeling audio/visual messages and physiologically derived signals, and the human source or recipient. Linear systems, difference equations, Z-transforms, sampling and sampling rate conversion, convolution, filtering, modulation, Fourier analysis, entropy, noise, Shannon’s fundamental theorems. Additional topics may include data compression, filter design, and feature detection. Meets with graduate subjects MAS.510 and MAS.511 but assignments differ.  
*V. M. Bove, Jr., R. W. Picard*

**MAS.234J Sensory and Social Orders**  
(Subject as 9.34J)  
Prereq: 9.00 or permission of instructor  
Acad Year 2009–2010: U (Fall)  
Acad Year 2010–2011: Not offered  
3-0-6  
See description under subject 9.34J.  
*W. A. Richards*

**MAS.235J Anigrafs**  
(Subject as 9.37J)  
Prereq: 9.34 or permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Fall)  
3-0-6  
See description under subject 9.37J.  
*W. A. Richards*

**MAS.241 Audio Processing by People and Machines**  
(Subject meets with 21M.566J, MAS.641J)  
Prereq: Permission of instructor  
U (Fall)  
3-0-6  
B. Vercoe

**MAS.402J Instrumentation and Measurement for Biological Systems**  
(Subject as 2.673J, 6.122J, 20.309J)  
(Subject meets with 20.409J)  
Prereq: Biology (GIR), Physics II (GIR), 6.00, 18.03; 2.001, 20.310, or 6.02; or permission of instructor; Coreq: 20.330  
U (Fall, Spring)  
3-6-3  
See description under subject 20.309J.  
Fall: S. Manalis, P. T. So, S. Wasserman  
Spring: E. Boyden, S. Wasserman, M. F. Yanik
MAS.511 Signals, Systems, and Information for Media Technology
Prereq: MAS.510 or 6.003, or permission of instructor
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
2-0-4
Fundamentals of signal processing and linear systems theory as applied to audio/visual messages and physiologically-derived signals. Linear systems, difference equation, Z-transforms, convolution, filtering. Additional topics may include filter design, feature detection, communication systems. Meets the second half of the term with subject MAS.160, but assignments differ.
V. M. Bove, Jr., R. W. Picard

MAS.531 Computational Camera and Photography (New)
(Subject meets with MAS.131)
Prereq: Permission of instructor
3-0-9
See description under subject MAS.131.
R. Raskar

MAS.532 Camera Culture (New)
(Subject meets with MAS.132)
Prereq: Permission of instructor
2-0-7
See description under subject MAS.132.
R. Raskar

MAS.533 Imaging Ventures: Cameras, Displays, and Visual Computing (New)
Prereq: Permission of instructor
0-9-0 H-LEVEL Grad Credit
Project-oriented seminar covers the opportunities and challenges for businesses based on emergent imaging innovations. Students analyze the landscape of imaging developments, plan business strategies and brainstorm towards a start-up, business unit, non-profit or citizen sector organization; they are encouraged to form teams and craft a business plan to gain practical experience in imaging research. Includes case studies of established and emerging businesses, and talks by invited business speakers. Surveys commercialization and the innovation landscape in all imaging arenas. Topics include mobile camera phones, cameras in developing countries, image-search, medical imaging, online photo sharing, and computational photography. Enrollment limited.
R. Raskar

MAS.551] Design Without Boundaries
(Subject meets with 4.556J)
Prereq: None
3-0-6 H-LEVEL Grad Credit
Focuses on the design and implementation of mobility-on-demand systems in dense urban environments, described as a fleet of lightweight electric vehicles placed at charging stations that are strategically distributed throughout the city. Students work in small teams and are lead by project leaders from the Smart Cities group. Projects will run throughout the term and include several joint design reviews with invited academic and industry guests.
W. Mitchell, F. Casalegno

MAS.552] Mobility-on-Demand (New)
(Subject meets as 4.557J)
Prereq: Permission of instructor
3-0-6 H-LEVEL Grad Credit
Focuses on the design and implementation of mobility-on-demand systems in dense urban environments, described as a fleet of lightweight electric vehicles placed at charging stations that are strategically distributed throughout the city. Students work in small teams and are lead by project leaders from the Smart Cities group. Projects will run throughout the term and include several joint design reviews with invited academic and industry guests.
W. Mitchell

MAS.610 Fundamentals of Visual Communication and Interaction Design (New)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
2-0-10 H-LEVEL Grad Credit
Introduction to visual communication, including typography, layout, color, and visualization with an emphasis on computational techniques. Demonstrates how interaction requires new design methods to present and explore information effectively. Assignments combine software and design.
D. Small


MAS.622J Pattern Recognition and Analysis
(Same subject as 1.126J)
Prereq: A working knowledge of probability theory and linear algebra
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Fundamentals of characterizing and recognizing patterns and features of interest in numerical data. Basic tools and theory for signal understanding problems with applications to user modeling, affect recognition, speech recognition and understanding, computer vision, physiological analysis, and more. Decision theory, statistical classification, maximum likelihood and Bayesian estimation, nonparametric methods, unsupervised learning and clustering. Additional topics on machine and human learning from active research. Enrollment limited to 20.
R. W. Picard

MAS.630 Affective Computing
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
2-0-10 H-LEVEL Grad Credit
Focuses on how to develop technologies that help people communicate emotion, that respectfully read and that intelligently respond to human emotion, and have internal mechanisms inspired by animal emotion. Topics vary from year to year, and may include the interaction of emotion with cognition and perception; the communication of human emotion via face, voice, physiology, and behavior; construction of computers, agents, and robots having skills of emotional intelligence; the role of emotion in decision-making and learning; and affective technologies for education, autism and health applications. Weekly reading, discussion, and a term project is required. Enrollment limited.
R. W. Picard

MAS.632 Speech Interfaces and Mobile Devices
Prereq: Permission of instructor
G (Fall)
Units arranged H-LEVEL Grad Credit
Interaction with mobile computing systems and telephones by voice, including speech synthesis, recognition, digital recording, and browsing recorded speech. Emphasis on human interface design issues and interaction techniques appropriate for cognitive requirements of speech. Topics include human speech production and perception, speech recognition and text-to-speech algorithms, telephone networks, and spatial and time-compressed listening. Extensive reading from current research literature.
C. Schmandt

MAS.641J Audio Processing by People and Machines
(Same subject as 21M.566J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Principles of information processing by the human auditory system, from detection of frequency, intensity, and spectrum, to the development of their perceptual correlates as pitch, loudness, and timbre. Machine models of the human auditory and musical experience using perceptually based sensor and interpreter constructs, sufficient to enable machines to experience sound and music in a manner related to our own. Exploring auditory and music cognition with the aid of real-time audio processors. Modeling musical common sense. Lectures same as MAS.241, with additional readings and a group or individual project.
B. Vercoe

MAS.642J Writing for Computer Performance
(Same subject as 21M.565J)
Prereq: MAS.641
G (Spring)
3-0-6 H-LEVEL Grad Credit
Use of current tools and techniques for creating audio soundtracks that can be synthesized by computer in real time. Techniques of compact definition and efficient, global dissemination, such as via the Web. Development and use of global standards for audio and music rendering on remote sites. Participants are expected to create an original work, performed in at least three remote sites to positive commentary, using the above principles.
B. Vercoe

MAS.654J Cognitive Architectures
(Same subject as 9.343J)
Prereq: Permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit
See description under subject 9.343J.
W. A. Richards

MAS.664J Media Lab Enterprises: Digital Innovations
(Same subject as 15.376J)
Prereq: None
G (Spring)
3-0-6
Can be repeated for credit
Seminar surveys internal and external entrepreneurship, based on Media Lab technologies, to increase understanding of how digital innovations grow into societal change. Cases illustrate examples of both successful and failed businesses, as well as difficulties in deploying and diffusing products. Explores a range of business models and opportunities enabled by emerging Media Lab innovations. Students craft a business analysis for one of the featured technology innovations. Past analyses have become the basis for research, publications, and new ventures. Particular focus on personal health care, mobile transactions, and new media.
A. Pentland, J. Bonsen, F. Moss

MAS.665J Development Ventures
(Same subject as 15.375J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Seminar on founding, financing, and building entrepreneurial ventures in developing nations. Challenges students to craft enduring and economically viable solutions to the problems faced by these countries. Cases illustrate examples of both successful and failed businesses, and the difficulties in deploying and diffusing products and services through entrepreneurial action. Explores a range of established and emerging business models, as well as new business opportunities enabled by emerging technologies in MIT labs and beyond. Students develop a business plan executive summary suitable for submission in the MIT $100K Entrepreneurship Competition $1K Warm-Up. Limited to 25.
A. Pentland, J. Bonsen

MAS.672 New Paradigms for Human-Computer Interaction
Prereq: Permission of instructor
G (Spring)
2-8-2 H-LEVEL Grad Credit
Focuses on radically novel approaches to human-computer interaction. Read and discuss seminal papers from the fields of ubiquitous computing, mixed reality, augmented reality, wearables, location-aware computing, ambient intelligence, ambient interfaces, tangible interfaces, e-textiles, smart networked objects, intelligent interfaces, sentient architecture, software agents and others. Students required to participate in the discussion of the weekly readings, to engage in the design of several applications and to complete one larger design and implementation project. Enrollment limited to 16.
P. Maes, H. Ishii
MAS.690 Special Projects in Media Arts and Sciences
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Special projects on individual or group basis. Registration subject to prior arrangement of subject matter and supervision by staff. Staff.

MAS.712 Special Topics in Creative Learning Technologies
Prereq: Permission of instructor
G (Spring)
2-0-7 H-LEVEL Grad Credit
Can be repeated for credit
Project-oriented subject focuses on current research in innovative educational technologies and creative learning environments. Students contribute directly to ongoing research projects through design activities and field tests. Students work in groups on final project. M. Resnick

MAS.714J Technologies for Creative Learning (Same subject as STS.445J)
Prereq: Permission of instructor
G (Fall)
2-0-7 H-LEVEL Grad Credit
Explores the design of innovative educational technologies and creative learning environments, drawing on specific case studies such as the LEGO Programmable Brick, Scratch software and Computer Clubhouse after-school learning centers. Includes activities with new educational technologies, reflections on learning experiences, and discussion of strategies and principles underlying the design of new tools and activities. M. Resnick

MAS.731J The Society of Mind (Same subject as 6.868J)
Prereq: Must have read The Society of Mind and The Emotion Machine; permission of instructor
G (Spring)
2-0-10 H-LEVEL Grad Credit
See description under subject 6.868J. M. Minsky

MAS.750 Human-Robot Interaction
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
2-0-7 H-LEVEL Grad Credit
In-depth exploration of the leading research, design principles, and technical challenges in human-robot interaction (HRI), with an emphasis on socially interactive robots. Topics include mixed-initiative interaction, multi-modal interfaces, face-to-face communication, human-robot teamwork, social learning, aspects of social cognition, and long-term interaction. Applications of these topics to the development of personal robots for health, education, elder care, domestic assistance, and other domains will be surveyed. Requires student presentations, critiques of class readings, student projects, and a final project including a publication quality paper. C. Breazeal

MAS.751J Relational Machines (Same subject as STS.447J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
2-0-7 H-LEVEL Grad Credit
Introduction to the issues, principles, and challenges toward building relational machines: technological artifacts that are designed to inspire a sense of relationship in their users. Sample applications include learning companions for children, assistive robots for the elderly, software agents that act as trainers or assistants, interactive game characters that engage in social relationships, or machines that cooperate with humans as members of human-robot teams. Readings cover a broad range of topics from psychology, sociology, and human-computer/robot interaction as well as how these ideas manifest in a wide range of applications for technological systems. Requires presentations and critiques of class readings and a final project that includes writing a scholarly paper. C. Breazeal, S. Turkle

MAS.755J Musical Aesthetics and Media Technology (Same subject as 21M.580J)
Prereq: Permission of instructor
G (Fall)
3-3-3 H-LEVEL Grad Credit
In-depth exploration of contemporary concepts in music and media. Studies recent music that uses advanced technology, and the artistic motivations and concerns implied by the new media. Practical experience with computer music technology, including MIDI and post-MIDI systems. Special emphasis on the interactive systems for professionals as well as amateurs. Midterm paper and term project required. T. Machover
MAS.826J Projects in Media and Music
(Same subject as 21M.581J)
Prereq: MAS.825J
G (Spring)
3-3-6 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor
Current computer music concepts and practice. Project-based work on research or production projects using the Media Lab’s computer music, interactive, and media resources. Requires significant studio work and a term project. Projects based on class interests and skills, and may be individually or group-based.
T. Machover

MAS.834 Tangible Interfaces
Prereq: Permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit
Explores design issues surrounding tangible user interfaces, a new form of human-computer interaction. Tangible user interfaces seek to realize seamless interfaces between humans, digital information, and the physical environment by giving physical form to digital information and computation, making bits directly manipulable with hands and perceptible at the periphery of human awareness. In the design studio environment, students explore experimental tangible interface designs, theories, applications, and underlying technologies, using concept sketches, posters, physical mockups, and working prototypes.
H. Ishii

MAS.836 Sensor Technologies for Interactive Environments
Prereq: Permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit
A broad introduction to a host of sensor technologies, illustrated by applications drawn from human-computer interfaces and ubiquitous computing. After extensively reviewing electronics for sensor signal conditioning, the lectures cover the principles and operation of a variety of sensor architectures and modalities, including pressure, strain, displacement, proximity, thermal, electric and magnetic field, optical, acoustics, RF, inertial, and bioelectric. Simple sensor processing algorithms and wired and wireless network standards are also discussed. Students are required to complete written assignments, a set of laboratories, and a final project.
J. Paradiso

MAS.837 Principles of Electronic Music Interfaces
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Explores the ways in which electronic music is controlled and performed. A solid historical perspective is presented, tracing the development of various families of electronic musical controllers and instruments from their genesis in the late 1800s onwards. Design principles and engineering detail are also given for various current and classic controllers. Evolving issues in the control of computer music for live performance and interactive installations are discussed, including computer mapping of sensor signals and transduced gesture onto sound, music, and other media. Weekly reading assignments are given, and a final project or paper is required.
J. Paradiso

MAS.862 The Physics of Information Technology
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit
Self-contained introduction to the governing equations for devices that collect, store, manipulate, transmit and present information. Provides an understanding of how operational device principles work, their uses, the limits on their performance, and how they might be improved. Students review the foundations of thermodynamics and noise, electromagnetics, and the quantum description of materials, and then study their application in areas such as semiconductor logic, magnetic storage, wireless and optical communications, and quantum information and computation.
N. Gershenfeld

MAS.863 How to Make (Almost) Anything
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Provides an introduction to the resources for designing and fabricating smart systems, including CAD/CAM/CAE; NC machining, 3-D printing and scanning, molding and casting, laser and waterjet cutting; PCB design and fabrication; sensors and actuators; analog instrumentation; embedded digital processing; wired and wireless communications. Emphasis on learning how to use and integrate these tools as well as understand how they work.
N. Gershenfeld, J. DiFrancesco

MAS.864 The Nature of Mathematical Modeling
Prereq: Permission of instructor
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Surveys the range of levels of description useful for the mathematical description of real and virtual worlds, including analytical solutions and approximations for difference and differential equations; finite difference, finite element and cellular automata numerical models; and stochastic processes, nonlinear function fitting, constrained optimization, and inference. Emphasis on efficient practical implementation of these ideas.
N. Gershenfeld

MAS.881J Principles of Neuroengineering
(Same subject as 9.422J, 20.452J)
Prereq: 8.03, 6.003, and 9.01; or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Covers principles underlying current and future technologies for brain analysis and engineering, for neurology, psychiatry, and neuroscience. Focuses on using biophysical, biochemical, and anatomical models to understand technology design constraints governing ability to observe and alter brain function. Topics include functional magnetic resonance imaging, electromagnetic recording/stimulation, neuropharmacology, optical cellular imaging, and gene/stem-cell therapy. Design projects by student teams. Enrollment limited to 28.
E. S. Boyden

MAS.882J Applications for Neuroengineering
(Same subject as 9.433J)
Prereq: MAS.881; or 6.003, 8.03, and 9.01. Permission of instructor also required
G (Spring)
1-8-3 H-LEVEL Grad Credit
Project-focused subject in which students take a top-down approach to developing technologies that address critical clinical and basic-science problems of human brain function. Focus is on application of engineering principles to development of systematically powerful tools. Problem domains include neurological/psychiatric disorders, consciousness, and human cognitive augmentation. Students work in teams to apply cross-disciplinary (molecular, physical, nanotechnological) building blocks to design new tools for the analysis and engineering of the brain. Enrollment limited to 14.
E. S. Boyden
Course mas.883 J neurotechnology ventures
(Same subject as 9.455J, 15.128J, 20.454J)
Prereq: Permission of instructor
G (Fall)
2-0-7 H-LEVEL Grad Credit
Special seminar focusing on the challenges of envisioning, planning, and building startups that are commercializing innovations from neuroscience and the blossoming domain of neuroengineering. Topics include neuroimaging and diagnostics, psychophysiology, rehab feedback, affective computing, neurotherapeutics, surgical tools, neuropharmaceuticals, deep brain stimulation, prosthetics and neurobionics, artificial senses, nerve regeneration, and more. Each class is devoted to a specific topic area. The first hour covers the topic in survey form. The second hour is dedicated to a live case study of a specific organization. A broad spectrum of issues, from the deeply technical through market opportunity, is explored in each class. This course is taught live between the University of Hong Kong and MIT.
E. S. Boyden, R. Ellis-Behnke, J. Bonsen

MAS.890 Special Projects in Media Arts and Sciences
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Special projects on individual or group basis. Registration subject to prior arrangement of subject matter and supervision by staff.
Staff

General

MAS.910 Research in Media Technology
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
For research assistants in Media Arts and Sciences, where the assigned research is approved for academic credit by the department.
Staff

MAS.912 Teaching in Media Arts and Sciences
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Laboratory, tutorial, or classroom teaching under the supervision of a Media Arts and Sciences faculty member. Students selected by interview.
Enrollment is limited by the availability of suitable teaching assignments.
Staff

MAS.921 Proseminar in Media Arts and Sciences
Prereq: Permission of instructor
G (Fall)
3-0-9 [P/D/F] H-LEVEL Grad Credit
Designed specifically for new doctoral students in the Media Arts and Sciences (MAS) program. Explores intellectual foundations of MAS, unifying themes connecting MAS research, and working practices of MAS researchers. Restricted to MAS doctoral students.
D. Roy

MAS.940 Preparation for SM Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Selection of thesis topic, definition of method of approach, and preparation of thesis proposal. Independent study supplemented by individual conferences with faculty. In some cases, coregistration with 21W.793 or equivalent required.
D. Roy, P. Maes

MAS.945 Preparation for General Exams
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
0-12-0 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Selected readings for Media Arts and Sciences doctoral students in preparation for their qualifying exams.
Staff

MAS.950 Preparation for PhD Thesis
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Selects thesis subject, defines method of approach, and prepares preliminary thesis outline. Independent study, supplemented by frequent individual conferences with staff members. Restricted to doctoral candidates.
Staff

MAS.960 Special Topics in Media Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
MAS.961–MAS.968 Special Topics in Media Technology
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
MAS.969 Special Topics in Media Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Staff

MAS.ThG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research and writing of thesis; to be arranged by the student with supervising committee.
Staff
D'ARBELOFF-FUNDED PILOT SUBJECTS

2.00A Fundamentals of Engineering Design: Explore Space, Sea and Earth
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
3.0-3.0-3
Students formulate and complete space/earth/ocean exploration-based design projects, including core engineering themes, principles, and modes of thinking. Specialized learning modules enable teams to focus on the knowledge required to complete their projects, such as machine elements, electronics, design process, visualization, and communication. Includes exercises in written and oral communication and team building. Examples of projects include surveying a lake for millfoil, from a remote controlled aircraft, and then sending out robotic harvesters to clear the invasive growth; and exploration for the evidence of life on a moon of Jupiter, with scientists participating through teleoperation. Includes problem-based learning. Students encounter the social, political, economic, and technological challenges of engineering practice by participating in actual engineering projects involving public transportation and information infrastructure with faculty and industry. Student teams create prototypes and mixed media reports with exercises in project planning, analysis, design, optimization, demonstration, reporting, and team building. Preference to freshmen. 
A. H. Techet, D. Newman

2.00B Toy Product Design
Prereq: None
U (Spring)
3.5-1
Provides students with an overview of design for entertainment and play, as well as opportunities in creative product design and community service. Students develop ideas for new toys that serve clients in the community, and work in teams with local sponsors and with experienced mentors on a themed toy design project. Students enhance creativity and experience fundamental aspects of the product development process, including determining customer needs, brainstorming, estimation, sketching, sketch modeling, concept development, design aesthetics, detailed design, and prototyping. Includes written, visual, and oral communication. Enrollment limited; preference to freshmen. 
D. R. Wallace

3.003 Principles of Engineering Practice
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
1.0-2.0-6
Introduces students to the interdisciplinary nature of 21st-century engineering projects with three threads of learning: a technical toolkit, a social science toolkit, and a methodology for problem-based learning. Students encounter the social, political, economic, and technological challenges of engineering practice by participating in actual engineering projects involving public transportation and information infrastructure with faculty and industry. Student teams create prototypes and mixed media reports with exercises in project planning, analysis, design, optimization, demonstration, reporting and team building. Preference to freshmen. 
L. Kimerling, R. Kirchain, C. Weaver, W. Uricchio, H. Einstein

4.001 CityScope
Prereq: None
U (Spring)
3.0-0-9 HASS
Project-based introduction to the contemporary city as a complex system within a context of limited resources and competing interests. Learn to assess scenarios for the purpose of formulating social, economic and design strategies that provide optimized solutions that are humane and sustainable. Group projects develop and advocate visions for housing, urban planning, regeneration of natural ecologies and other sectors of the city. Travel may be involved that will be funded, but not required. Includes exercises in written and oral communication and team building. Limited to 15 participants. Preference to freshmen. 
J. Fernandez, P. Thompson

5.92 Energy in the Local Community
Prereq: Permission of instructor
U (Spring)
4.0-2.0-6
Explores energy issues and community dynamics at the local level: on the MIT campus and in the cities of Cambridge and Boston. Staff in the Laboratory for Energy and the Environment work with community contacts to develop project ideas of concern to community leaders that have potential to affect local energy management. Students are involved in all aspects of project design, from the refinement of research questions to conclusions and presentation of findings. Includes exercises in written and oral communication and team building. Enrollment limited; preference to freshmen. 
J. Fernandez, P. Thompson

6.07 Projects in Microscale Engineering for the Life Sciences
Prereq: None
U (Spring)
2.0-4.0-3
A project-based introduction to manipulating and characterizing cells and biological molecules using microfabricated tools. In the first half of the term, students perform laboratory exercises designed to introduce the design, manufacture, and use of microfluidic channels; techniques for sorting and manipulating cells and biomolecules; and making quantitative measurements using optical detection and fluorescent labeling. In the second half of the term, students work in small groups to design and test a microfluidic device to solve a real-world problem of their choosing. Includes exercises in written and oral communication and team building. Enrollment limited to 20; preference to freshmen. 
D. Freeman, M. Gray, A. Aranyosi

11.004 CityScope
Prereq: None
U (Spring)
3.0-0-9 HASS
Project-based introduction to the contemporary city as a complex system within a context of limited resources and competing interests. Learn to assess scenarios for the purpose of formulating social, economic and design strategies that provide optimized solutions that are humane and sustainable. Group projects develop and advocate visions for housing, urban planning, regeneration of natural ecologies and other sectors of the city. Travel may be involved that will be funded, but not required. Includes exercises in written and oral communication and team building. Limited to 15 participants. Preference to freshmen. 
J. Fernandez, P. Thompson
12.000 Solving Complex Problems
Prereq: None
U (Fall)
1-2-6
Provides an opportunity for entering freshmen to gain first-hand experience in integrating the work of small teams to develop effective solutions to complex problems in Earth system science and engineering. Each year’s class explores a different problem in detail through the study of complementary case histories and the development of creative solution strategies. Includes exercises in website development, written and oral communication, and team building. Subject required for students in the Terrascope freshman program, but participation in Terrascope is not required of all 12.000 students. Students who pass 12.000 and are in the Terrascope program are eligible to participate in the Terrascope field trip the following spring. Enrollment limited to freshmen.
S. A. Bowring

16.00 Introduction to Aerospace and Design
Prereq: None
U (Spring)
3-1-5
The fundamental concepts and approaches of aerospace engineering are highlighted through lectures on aeronautics, astronautics, and design. Active learning aerospace modules make use of information technology. Student teams are immersed in a hands-on, lighter-than-air (LTA) vehicle design project where they design, build, and fly radio-controlled LTA vehicles. The connections between theory and practice are realized in the design exercises. Required design reviews precede the LTA race competition. The performance, weight, and principle characteristics of the LTA vehicles are estimated and illustrated using physics, mathematics, and chemistry known to freshmen, the emphasis being on the application of this knowledge to aerospace engineering and design rather than on exposure to new science and mathematics. Includes exercises in written and oral communication and team building.
J. A. Hoffman

16.00A] Fundamentals of Engineering Design:
Explore Space, Sea and Earth
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
3-3-3
Student teams formulate and complete space/earth/ocean exploration-based design projects with weekly milestones. Introduces core engineering themes, principles, and modes of thinking. Specialized learning modules enable teams to focus on the knowledge required to complete their projects, such as machine elements, electronics, design process, visualization and communication. Includes exercises in written and oral communication and team building. Examples of projects include surveying a lake for milfoil, from a remote controlled aircraft, and then sending out robotic harvesters to clear the invasive growth; and exploration to search for the evidence of life on a moon of Jupiter, with scientists participating through teleoperation and supervisory control of robots. Enrollment limited; preference to freshmen.
A. H. Techet, D. Newman

20.020 Introduction to Biological Engineering Design
Prereq: None
U (Spring)
3-3-3
A project-based introduction to the engineering of synthetic biological systems. Throughout the term, students develop projects that are responsive to real-world problems of their choosing, and whose solutions depend on biological technologies. Lectures, discussions, and studio exercises will introduce (1) components and control of prokaryotic and eukaryotic behavior, (2) DNA synthesis, standards, and abstraction in biological engineering, and (3) issues of human practice, including biological safety; security; ownership, sharing, and innovation; and ethics. Preference to freshmen.
N. Kuldell

HST.410J Projects in Microscale Engineering for the Life Sciences
Prereq: None
U (Spring)
2-4-3
A project-based introduction to manipulating and characterizing cells and biological molecules using microfabricated tools. In the first half of the term, students perform laboratory exercises designed to introduce the design, manufacture, and use of microfluidic channels; techniques for sorting and manipulating cells and biomolecules; and making quantitative measurements using optical detection and fluorescent labeling. In the second half of the term, students work in small groups to design and test a microfluidic device to solve a real-world problem of their choosing. Includes exercises in written and oral communication and team building. Enrollment limited to 20; preference to freshmen.
D. Freeman, M. Gray, A. Aranyosi
ROTC subjects do not carry academic credit at MIT, but they can be counted toward the PE requirement (up to two points per year with a maximum of four points).

AEROSPACE STUDIES

AS.101 The Foundations of the United States Air Force
Prereq: None. Coreq: AS.111
U (Fall) 1-0-1
AS.102 The Foundations of the United States Air Force
Prereq: AS.101 or permission of instructor; Coreq: AS.112
U (Spring) 1-0-1
Survey designed to introduce students to the United States Air Force and Air Force Reserve Officer Training Corps. Topics include mission and organization of the Air Force, officer training, professionalism, military customs and courtesies, Air Force officer opportunities, group leadership problems, and an introduction to communication skills. AS.102 is a continuation of AS.101.
K. Hort

AS.111 Leadership Laboratory
Prereq: None. Coreq: AS.101
U (Fall) 0-2-2 [P/D/F]
AS.112 Leadership Laboratory
Prereq: AS.111 or permission of instructor; Coreq: AS.102
U (Spring) 0-2-2 [P/D/F]
Includes a study of Air Force customs and courtesies, drill and ceremonies, and military commands. Also includes studying the environment of an Air Force officer and learning about areas of opportunity available to commissioned officers, as well as interviews, guidance, and information to increase the understanding, motivation, and performance of other cadets. AS.112 is a continuation of AS.111.
M. Keller

AS.201 The Evolution of USAF Air and Space Power
Prereq: AS.102 or permission of instructor; Coreq: AS.211
U (Fall) 1-0-1
AS.202 The Evolution of USAF Air and Space Power
Prereq: AS.201 or permission of instructor; Coreq: AS.212
U (Spring) 1-0-1
Survey designed to facilitate the transition from Air Force ROTC cadet to Air Force ROTC officer candidate. Topics include Air Force heritage and leaders, Quality Air Force, an introduction to ethics and values, introduction to leadership, group leadership problems, and continuing application of communication skills. AS.202 is a continuation of AS.201.
T. Slauenwhite

AS.211 Leadership Laboratory
Prereq: AS.112 or permission of instructor; Coreq: AS.201
U (Fall) 0-2-2 [P/D/F]
AS.212 Leadership Laboratory
Prereq: AS.211 or permission of instructor; Coreq: AS.202
U (Spring) 0-2-2 [P/D/F]
Emphasizes development of techniques used to direct and inform. Students are assigned leadership and management positions in the AS.111 programs described above. AS.211 is taken simultaneously with AS.201. AS.212 is a continuation of AS.211.
M. Keller

AS.301 Air Force Leadership Studies
Prereq: AS.202 or permission of instructor; Coreq: AS.311
U (Fall) 3-0-3
AS.302 Air Force Leadership Studies
Prereq: AS.301 or permission of instructor; Coreq: AS.312
U (Spring) 3-0-3
Study of leadership, quality management fundamentals, professional knowledge, Air Force doctrine, leadership ethics, and communication skills required of an Air Force junior officer. Case studies are used to examine Air Force leadership and management situations as a means of demonstrating and exercising practical application of the concepts being studied. AS.302 is a continuation of AS.301.
M. Keller

AS.311 Leadership Laboratory
Prereq: AS.212 or permission of instructor; Coreq: AS.301
U (Fall) 0-2-4 [P/D/F]
AS.312 Leadership Laboratory
Prereq: AS.311 or permission of instructor; Coreq: AS.302
U (Spring) 0-2-4 [P/D/F]
Consists of activities classified as advanced leadership experiences that involve the planning and controlling of military activities of the cadet corps and the preparation and presentation of briefings and other oral and written communications. Also includes interviews, guidance, and information to increase the understanding, motivation, and performance of other cadets. AS.312 is a continuation of AS.311.
M. Keller
AS.401 National Security Affairs/Preparation for Active Duty
Prereq: AS.302 or permission of instructor; Coreq: AS.411
U (Fall) 3-0-9

AS.402 National Security Affairs/Preparation for Active Duty
Prereq: AS.401 or permission of instructor; Coreq: AS.412
U (Spring) 3-0-3

Introduction to the personal challenges and stresses of leadership, officer-time management, physical fitness, and stress management in relation to leadership, officership, and the Army profession. The focus is on developing basic knowledge and comprehension of Army leadership dimensions while gaining a big-picture understanding of ROTC, its purpose in the Army, and its advantages for the student.

C. Santiago

MS.102 Introduction to Tactical Leadership
Prereq: MS.101 or permission of instructor
U (Spring) 1-4-1

Overview of leadership fundamentals such as setting direction, problem solving, listening, presenting briefs, providing feedback, and effective writing skills. Students explore dimensions of leadership values, attributes, skills, and actions in the context of practical, hands-on, and interactive exercises. Professor of Military Science role models and the building of stronger relationships among students through common experience and practical interaction are critical aspects of the teambuilding and leadership exercises.

C. Santiago

MS.201 Innovative Team Leadership
Prereq: MS.102 or permission of instructor
U (Fall) 1-4-1

Explores the dimensions of tactical leadership strategies and styles by examining team dynamics and two historical leadership theories that form the basis of the Army leadership framework. Instruction covers aspects of personal motivation and teambuilding in the context of planning, executing, and assessing team exercises and participation in Leadership Labs. Focus is on continued development of leadership values and attributes through an understanding of Army rank, structure, and duties and basic aspects of land navigation and squad tactics. Case studies provide context for learning the Soldier's Creed and Warrior Ethos as they apply in the Contemporary Operating Environment. Focus is on situational awareness and skills in leading tactical operations. Students are taught to lead up to platoon-level after covering squad-level tactics in MS.301. Course provides review of aspects of combat, stability, and support operations. Students will conduct military briefings and develop proficiency in garrison operation orders. The focus is on exploring, evaluating, and developing skills in decision making, persuading, and motivating team members in the Contemporary Operating Environment. Students are evaluated on what they know and do as leaders as they prepare to attend the Leadership Development Assessment Course (LDAC). Evaluations are presented with the demands of preparing for the ROTC Leader Development Assessment Course (LDAC). Scenarios related to small unit tactical operations are used to develop self-awareness and critical thinking skills. Students receive systematic and specific feedback on their leadership abilities. Students are taught to analyze and evaluate their own leadership values, attributes, skills, and actions. Primary attention is given to preparation for LDAC and the development of leadership abilities.

M. Chaneys, K. Karwowski

MS.202 Foundations of Tactical Leadership
Prereq: MS.201 or permission of instructor
U (Spring) 1-4-1

Examines the challenges of leading teams in the Contemporary Operating Environment. Highlights dimensions of terrain analysis, patrolling, and operation orders. Further study of the theoretical basis of the Army leadership framework explores the dynamics of adaptive leadership in the context of military operations. Students are taught greater self-awareness as they assess their own leadership styles and practice communication and team building skills. Contemporary Operating Environment case studies give insight into the importance and practice of teamwork and tactics in real-world scenarios.

N. Griffiths

MS.301 Adaptive Team Leadership
Prereq: MS.202 or permission of instructor
U (Fall) 2-3-1

Challenges students to study, practice, and evaluate adaptive leadership skills as they are presented with the demands of preparing for the ROTC Leader Development Assessment Course (LDAC). Scenarios related to small unit tactical operations are used to develop self-awareness and critical thinking skills. Students receive systematic and specific feedback on their leadership abilities. Students are taught to analyze and evaluate their own leadership values, attributes, skills, and actions. Primary attention is given to preparation for LDAC and the development of leadership abilities.

M. Chaneys, K. Karwowski

MS.302 Leadership in Changing Environments
Prereq: MS.301
U (Spring) 2-3-1

Increasingly intense situational leadership challenges are applied to build student awareness and skills in leading tactical operations. Students are taught to lead up to platoon-level after covering squad-level tactics in MS.301. Course provides review of aspects of combat, stability, and support operations. Students will conduct military briefings and develop proficiency in garrison operation orders. The focus is on exploring, evaluating, and developing skills in decision making, persuading, and motivating team members in the Contemporary Operating Environment. Students are evaluated on what they know and do as leaders as they prepare to attend the Leadership Development Assessment Course (LDAC). Evaluations are presented with the demands of preparing for the ROTC Leader Development Assessment Course (LDAC). Scenarios related to small unit tactical operations are used to develop self-awareness and critical thinking skills. Students receive systematic and specific feedback on their leadership abilities. Students are taught to analyze and evaluate their own leadership values, attributes, skills, and actions. Primary attention is given to preparation for LDAC and the development of leadership abilities.

M. Chaneys, K. Karwowski

MS.310 Leadership Laboratory I
Prereq: MS.302 or permission of instructor; Coreq: MS.302
U (Fall) 0-2-1

Collective training in fundamentals of small unit tactics, drill, and ceremony, and the practice of individual military skills under field conditions off campus. Includes one weekend of field adventure training focused on teambuilding.

N. Griffiths
through completion of leaders reaction course, obstacle course, marksmanship, and rappelling. 
M. Chaney, K. Karwowski

**MS.312 Leadership Laboratory II**
Prereq: MS.311, Coreq: MS.302
U (Spring)
0-2-1
Continues the development of skills taught in MS.311. Prepares students for the Leadership Development and Assessment Course (LDAC) the following summer. Provides multiple venues for student evaluation under the Leadership Development Program (LDP). Culminates in a weekend Field Training Exercise (FTX), practicing platoon tactics, land navigation, command and control, and patrolling. Voluntary opportunities exist for airborne school, air assault school, mountain warfare school, and advanced marksmanship training.
M. Chaney, K. Karwowski

**MS.401 Developing Adaptive Leaders**
Prereq: MS.302
U (Fall)
1-3-5
Develops student proficiency in planning, executing, and assessing complex operations, functioning as a member of a staff, and providing leadership-performance feedback to subordinates. Students are given situational opportunities to assess risk, make ethical decisions, and provide coaching to fellow ROTC students. Students are measured by their ability to both give and receive systematic and specific feedback on leadership abilities. Students analyze and evaluate the leadership values, attributes, skills, and actions of MS.301 and MS.302 students while simultaneously considering their own leadership skills. Attention is given to preparation for the Basic Officer Leadership Course II (BOLC II) and the development of leadership abilities.
T. Hall

**MS.402 Leadership in a Complex World**
Prereq: MS.401
U (Spring)
1-3-5
Explores the dynamics of leading in the complex situations of current military operations in the Contemporary Operating Environment. Students examine differences in customs and courtesies, military law, principles of war, and rules of engagement in the face of international terrorism. Instruction also covers aspects of interacting with nongovernmental organizations, civilians on the battlefield, and host nation support.
Significant emphasis is placed on preparing students for their first unit of assignment as Army Second Lieutenants. Case studies, scenarios, and other exercises are used to prepare students to face the complex ethical and practical demands of leading as commissioned officers in the US Army/Army Reserves or Army National Guard.

**MS.411 Advanced Leadership Laboratory I**
Prereq: MS.312, Coreq: MS.401/15.305
U (Fall)
0-2-4
Designed to develop technical, tactical, and leadership skills while assessing officer/leader potential. Through assignment to leadership positions in both command and staff capacities, students actively participate in the planning and execution of training within the program, directing and controlling the corps of cadets, enhancing oral and written communications, and the application of troop-leading procedures and mission analysis.
L. McGonagle

**MS.412 Advanced Leadership Laboratory II**
Prereq: MS.411
U (Spring)
0-2-4
Continuation of MS.411. Prepares students for the Basic Officer Leadership Course II and III (BOLC II and III) the following summer/fall/spring. Continued student development and evaluation under the Leadership Development Program (LDP). Culminates in a second weekend Field Training Exercise (FTX) practicing platoon tactics, land navigation, command and control, and patrolling. Includes preparation for the transition from student to Second Lieutenant in the US Army/Army Reserves or Army National Guard.
T. Hall

**Naval Science**

**NS.100 Naval Science Leadership Seminar**
(Subject meets with NS.100, NS.300, NS.400)
Prereq: None
U (Fall, Spring)
0-2-2 [P/D/F]
Leadership seminar addresses professional issues of military leadership, ethics, foreign policy, internal affairs and naval warfare doctrine. Subject matter centers on preparation for commissioned service in the US Naval Forces by examining the role of the junior officer in the employment of naval power. Mostly student originated, the periods include panel discussions, practical applications, guest lecturers from academia, and speakers currently serving in deployed naval forces.
C. Shehadi, C. Frantz, T. Battles

**NS.101 Introduction to Naval Science**
Prereq: None
U (Fall)
2-0-1
Introduction to naval science. General introduction to the US Navy and Marine Corps. Emphasizes organizational structure, warfare components, and assigned roles/missions of US Navy/USMC. Covers all aspects of naval service from its relative position within DOD, to specific warfare communities/career paths. Also includes basic elements of leadership/Navy core values. Designed to give student initial exposure to many elements of naval culture. Provides students with conceptual framework and working vocabulary.
C. Shehadi

**NS.102 Naval Ships Systems**
Prereq: None
U (Fall)
3-0-3
Lecture series on technological fundamentals of applied and planned naval ships systems from an engineering viewpoint. Topics include stability, propulsion, ship control and systems.
C. Frantz

**NS.200 Naval Science Leadership Seminar**
(Subject meets with NS.100, NS.300, NS.400)
Prereq: None
U (Fall, Spring)
0-2-2 [P/D/F]
See description under subject NS.100.
C. Shehadi, C. Frantz, T. Battles

**NS.201 Naval Weapons Systems**
Prereq: Physics I (GIR), Calculus II (GIR) recommended
U (Spring)
3-0-3
Overview of the properties and behavior of electromagnetic radiation pertaining to maritime applications. Topics include communications, radar detection, electro-optics, tracking and guidance systems. Sonar and underwater sound propagation also discussed. Examples taken from systems found on naval ships and aircraft. Selected readings on naval weapons and fire control systems.
C. Frantz
NS.202 Seapower and Maritime Affairs
Prereq: None
U (Spring)
2-0-2
A study of the US Navy and the influence of sea power upon history. Incorporates both a historical and political science process to explore the major events, attitudes, personalities, and circumstances which have imbued the US Navy with its proud history and rich tradition. It deals with issues of national imperatives in peacetime as well as war, varying maritime philosophies which were interpreted into naval strategies/doctrines, budgetary concerns which shaped force realities, and the pursuit of American diplomatic objectives, concluding with the current search for direction in the post Cold War era and beyond.
C. Shehadi

NS.300 Naval Science Leadership Seminar
(Subject meets with NS.100, NS.200, NS.400)
Prereq: None
U (Fall, Spring)
0-2-2 [P/D/F]
See description under subject NS.100.
C. Shehadi, C. Frantz, T. Battles

NS.301 Coastal Piloting and Celestial Navigation
Prereq: Recommended second class cruise
U (Fall)
2-2-4
Comprehensive study of the theory, principles, and procedures of piloting and celestial navigation, including mathematics of navigation, practical work involving navigational instruments, sight reduction by pro forma and computerized methods, charts, publications, and voyage planning.
T. Battles

NS.302 Navigation and Naval Operations
Prereq: Recommended second class cruise and NS.301
U (Spring)
3-0-3
Comprehensive study of tactical and strategic considerations to the employment of naval forces, including communications, tactical formations and dispositions, relative motion, maneuvering board, and nautical rules of the road.
T. Battles

NS.310 Evolution of Warfare
Prereq: None
U (Fall)
2-0-4
Traces development of warfare from dawn of recorded history to present, focusing on the impact of major military theorists, strategists, tacticians, and technological developments. Seeks to understand the relationships between military training, weaponry, strategies and tactics, and the societies and cultures that produce and then are defended by those military structures. By examining the association between a society and its military, students acquire basic sense of strategy, develop an understanding of military alternatives, and see the impact of historical precedents on military thoughts and actions.
C. Milne

NS.400 Naval Science Leadership Seminar
(Subject meets with NS.100, NS.200, NS.300)
Prereq: None
U (Fall, Spring)
0-2-2 [P/D/F]
See description under subject NS.100.
C. Shehadi, C. Frantz, T. Battles

NS.401 Leadership and Management I
Prereq: NS.101
U (Fall)
3-0-3
Explores leadership from the military perspective taught by professors of military science from the Army, Navy and Air Force. Survey of basic principles for successfully managing and leading people, particularly in public service and the military. Develops skills in topics such as oral and written communication techniques, planning, team building, motivation, ethics, decision-making, and managing change. Relies heavily on interactive experiential classes with case studies, student presentations, role plays, and discussion. Also appropriate for non-management science majors.
T. Fohr

NS.402 Leadership and Ethics
Prereq: None
U (Spring)
3-0-3
Analyzes ethical decision-making and leadership principles. Students read and discuss texts written by such philosophers as Aristotle, Kant, and Mill to gain familiarity with the realm of ethical theory. Students then move on to case studies in which they apply these theories to resolve moral dilemmas. Provides a basic background in the duties and responsibilities of a junior division and watch officer; strong emphasis on the junior officer’s responsibilities in training, counseling, and career development. Student familiarization with equal opportunity and drug/alcohol rehabilitation programs. Principles of leadership reinforced through leadership case studies.
C. Stevens

NS.410 Evolution of Expeditionary Doctrine
Prereq: None
U (Spring)
2-0-4
Historical and tactical analysis of expeditionary doctrine, from its roots in amphibious warfare to current actions and future developments. Seeks to define the concept, explore its doctrinal origins, and trace its evolution as an element of naval policy throughout and beyond the 20th century. Case study approach used to provide the prospective Marine Corps officer with the fundamentals of expeditionary maneuver warfare on doctrinal, strategic, operational, tactical and technological levels.
C. Milne
INTERPHASE:
PRE-FRESHMAN SUMMER PROGRAM

SP.100 Interphase
Prereq: Commitment to register as a freshman in the Fall
U (Summer)
Units arranged

A seven-week academic skills-honing program, Interphase is designed to enhance the preparedness of students entering MIT in the fall term. The program has a dual focus: academic readiness and general educational development. The program involves calculus, chemistry, physical education, physics, writing, and supporting academic activities, including small-group learning. The students can earn transcript credit for subjects taken in the program, sometimes resulting in advanced placement in corresponding subjects taken in the fall. Activities include day trips to area cultural, recreational, and business sites. Students participate in a range of personal and educational development seminars and activities designed to ensure their smooth transition to college life. The summer experience gives them increased opportunity to prepare for the rigors of an MIT full-subject load.

T. Stevens

SEMINAR XL

SEM.XL1 Program XL: You Can Be a Success at MIT
Prereq: First-year undergraduate standing
U (Fall)
Units arranged [P/D/F]

SEM.XL2 Program XL: You Can Be a Success at MIT
Prereq: First-year undergraduate standing
U (Spring)
Units arranged [P/D/F]

An academic enrichment program for first-year students, XL utilizes the innovative and effective small-group learning concept to enhance students’ academic performance in calculus and science. Students meet in study groups of five to six participants with facilitators trained in effective classroom techniques and concept focus. The study groups help students to reinforce concepts learned in the regular curriculum, and help them to gain mastery of concepts and problems that are often more challenging than those dealt with during lecture. The small study group format emphasizes the full participation of each student with the facilitator acting as a guide. The regularity of weekly meetings enhances the students’ understanding of MIT’s academic expectations. After the initial meetings, students are encouraged to take more responsibility and to lead the group in problem-solving sessions, which helps to maximize their own learning. Each study group meets for a minimum of three hours each week. The meeting time is set by the XL facilitator based on students’ schedules.

S. Mtingwa

EXPERIMENTAL STUDY GROUP

SP.211 ESG (Experimental Study Group)
Prereq: None
U (Fall)
Units arranged [P/D/F]

SP.212 ESG (Experimental Study Group)
Prereq: None
U (Spring)
Units arranged [P/D/F]

An innovative and personalized program for first-year students who wish to take a more active role in their MIT education. In place of lectures and large classes, ESG students take their core subjects through small interactive classes, seminars, and independent study projects, with opportunity for more flexibility in pace and scheduling than is normally available in the regular curriculum. Credit is available in freshman subjects in biology, chemistry, mathematics, and physics, as well as several HASS, HASS-D, and CI-H offerings. Certain sophomore-level subjects can be studied in ESG, depending on staff and student interest. Undergraduate seminars in a variety of areas are also offered, including psychology, energy, and chemistry. Students are expected to take the majority of their classes in ESG but may take one or two classes in the regular curriculum. Staff includes MIT faculty, lecturers, graduate students, and undergraduate instructors who are interested in teaching in a small and informal academic community.

A. Slocum

SP.221 ESG (Experimental Study Group)
Prereq: SP.211 and/or SP.212
U (Fall)
Units arranged [P/D/F]

SP.222 ESG (Experimental Study Group)
Prereq: SP.211 and/or SP.212
U (Spring)
Units arranged [P/D/F]

Continuation of ESG for sophomores.

A. Slocum

SP.231 ESG Undergraduate Teaching
Prereq: SP.211 or SP.212
U (Fall)
Units arranged [P/D/F]

SP.232 ESG Undergraduate Teaching
Prereq: SP.211 or SP.212
U (Spring)
Units arranged [P/D/F]

An opportunity to assist in the teaching of subjects in ESG in biology, chemistry, humanities and social sciences, mathematics, and physics. Student instructors may be involved in grading, running problem solving sessions, or teaching classes depending on experience and interest. Qualified students may also develop and teach undergraduate seminars under the supervision of an appropriate faculty or staff member. Student instructors meet weekly with staff to discuss their teaching and cover a variety of topics related to effective teaching techniques.

A. Slocum

SP.233 ESG Special Topics
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]

Can be repeated for credit

Independent study projects which are not covered in the regular ESG offerings. These projects require prior approval and regular supervision by a staff member, as well as a written proposal and a final report.

A. Slocum
SP.2H1 Philosophy of Love
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Can be repeated for credit
Explores the nature of love through works of philosophy, literature, film, poetry, and individual experience. Investigates the distinction among eros, philia, and agape. Students discuss ideas of love as a feeling, an action, a species of "knowing someone," or a way to give or take. Authors include Plato, Kant, Buber, D.H. Lawrence, Rumi, and Aristotle.
L. Perlman

SP.2H2 Readings in the Philosophy of Technology
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Surveys various conceptions of the nature of science and society and how they relate to each other. Examines fundamental alternative views through the works of Aristotle, Bacon, Rousseau, Nietzsche, and Weber. Topics include goals, meaning, beneficence, and manipulability of nature and human nature; the relation between wisdom, power, goodness, and happiness; and the character and direction of modern politics and science.
S. Minkov

SP.2H3 Ancient Philosophy and Mathematics
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 2, CI-H
Explores the relationship between ancient Greek philosophy and mathematics. Investigates how ideas of definition, reason, argument and proof, rationality/irrationality, number, quality and quantity, truth, and even the idea of an idea were shaped by the interplay of philosophic and mathematical inquiry. Examines how discovery of the incommensurability of magnitudes challenged the Greek presumption that the cosmos is fully understandable. Explores the influence of mathematics on ancient Greek ethical theories. Authors: Euclid, Plato, Aristotle, Nicomachus, Theon of Smyrna, Bacon, Descartes, Dedekind, and Newton. Priority given to students in the Experimental Study Group.
L. Perlman

SP.2UR Undergraduate Research in ESG
Prereq: None
U (Fall, IAP, Summer)
Units arranged [P/D/F]
Can be repeated for credit
For students wishing to pursue undergraduate research opportunities in the Experimental Study Group.
A. Stlocum

CONCOURSE PROGRAM

SP.311 Concourse Program
Prereq: None
U (Fall)
Units arranged [P/D/F]

SP.312 Concourse Program
Prereq: None
U (Spring)
Units arranged [P/D/F]
An integrative program for the freshman year. Staff includes faculty from the Schools of Science, Engineering, and Humanities and Social Science. Credits in Concourse fulfill the General Institute Requirements and are so recorded.
B. L. Trout

SP.313 Concourse Program for Upperclassmen
Prereq: Permission of instructor
U (Spring)
Units arranged [P/D/F]
Can be repeated for credit
For students wishing to pursue additional humanities or writing subjects in Concourse beyond freshman year. Subject matter changes from year to year.
Staff

SP.314 Love and Aggression
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS-D, Category 1, CI-H
Subject explores the interrelated topics of love and aggression from the vantage points of literature and psychology. Students read a series of texts from Biblical excerpts to the modern novel. Lectures, classroom discussions, and writing assignments consider whether the text deliberately or unintentionally borrows from psychological theory. Enrollment limited and restricted to students enrolled in Concourse.
J. Wolfe, W. Kelley

SP.315 Concourse Program Undergraduate Teaching
Prereq: SP.311 or SP.312; permission of instructor
U (Fall)
Units arranged
Can be repeated for credit

SP.316 Concourse Program Undergraduate Teaching
Prereq: SP.311 or SP.312; permission of instructor
U (Spring)
Units arranged
Can be repeated for credit
Tutoring, leadership of study and review groups, seminars and recitations in the Concourse Program, under the supervision of senior Concourse staff.
Staff

SP.317 Memory and Literature
Prereq: None
Acad Year 2009–2010: U (Spring)
Acad Year 2010–2011: Not offered
3-0-9 HASS-D, Category 1, CI-H
There are many forms of memory. Memories can be explicit or implicit, hidden from conscious awareness. They can be long lasting or fleeting, individual or held by a group. Examines this diversity of memory through works of literature. Specific topics include the nature of historical memory: how it changes over time and place, the connection between memory and art, and repressed or hidden memories. Illustrated with readings from psychological sources as well as ancient and modern literature. Group and individual oral presentations. Restricted to students enrolled in Concourse. Limited enrollment.
J. Wolfe, J. Hildebidle

SP.318 Introduction to Psychology
Prereq: None
U (Fall)
4-0-8 HASS
Credit cannot also be received for 9.00
A survey of the scientific study of human nature, including how the mind works, and how the brain supports the mind. Topics include the mental and neural bases of perception, emotion, learning, memory, cognition, child development, personality, psychopathology, and social interaction. Consideration of how such knowledge relates to debates about nature and nurture, free will, consciousness, human differences, and self and society. Restricted to students enrolled in Concourse.
J. Wolfe
SP.321 Madness and Literature
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS-D, Category 1, CI-H
Examines “madness” (or, more technically, abnormal behavior) through the lens of literature; how literature reveals changes in the conceptions of madness over time and how literature can offer a glimpse of the first-person experience of madness. Considers the long-standing, folk-psychological theory that there is a link between art and madness. Enrollment limited and restricted to students enrolled in Concourse. J. Wolfe, J. Hildebidle

SP.322 Prohibition and Permission
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS-D, Category 1, CI-H
Explore where the prohibitions and permissions that occur in every day life come from, why they exist, and what gives them force. For example: food- you are only willing and able to eat a subset of the world’s edible substances. Marriage- some marriages are prohibited by law or by custom. Addresses questions of prohibition and permission using psychological sources and literary works from ancient to modern. Includes texts by Shakespeare, Melville, Mary Rowlandson, and Anita Desai. Students give group and individual oral presentations. Enrollment is restricted to Concourse students and limited to 18 students per section. J. Wolfe, W. Kelley

SP.343–SP.344 Concourse Special Topics
Prereq: Permission of instructor
U (Spring)
Units arranged [P/D/F]
Can be repeated for credit
Open to students enrolled in Concourse who wish to pursue topics not covered in the regular Concourse offerings. Topics change from year to year. B. L. Trout

SP.345, SP.346, SP.347 Concourse Special Topics for IAP
Prereq: Permission of instructor
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit
Open to students who wish to pursue topics over IAP not covered in the regular Concourse offerings. Topics change from year to year. B. L. Trout

SP.3UR Undergraduate Research Opportunities in Concourse
Prereq: None. Coreq: SP.311 or SP.312
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
For students wishing to pursue undergraduate research opportunities in Concourse. B. L. Trout

TERRASCOPE

SP.35UR Undergraduate Research in Terrascope
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Staff

SP.360 Terrascope Radio
Prereq: None. Coreq: 1.016
U (Spring)
3-3-6 HASS, CI-H
An exploration of radio as a medium of expression and communication, particularly the communication of complex scientific or technical information to general audiences. Examines the ingredients of effective radio programming, drawing extensively on examples from both commercial and public radio. Student teams produce, assemble, narrate, record and broadcast/webcast radio programs on topics related to the complex environmental issue that is the focus of the Terrascope subjects. Includes multiple individual writing assignments that explore the constraints and opportunities in radio as a medium. Limited to 12. Terrascope students only. A. W. Epstein, R. L. Bras

EDGERTON CENTER

For a full listing of classes offered by the Edgerton Center, as well as class descriptions, please visit the Edgerton Center Course website. (http://web.mit.edu/Edgerton/www/Courses.html)

SP.3702 Introduction to Digital Electronics
(Same subject as 6.072I)
Prereq: None
U (Fall, IAP, Spring)
0-3-3 [P/D/F]
Design your own circuits for times when off-the-shelf solutions are not available. Seminar begins with assembly of a utility board. Weekly labs cover digital logic gates, memory elements, and finite-state machine design. Seminar concludes with a team-based design project. Preference given to freshmen. Maximum of 10 students per term, lottery at the first class session if oversubscribed. J. Bales

SP.705J Electronics Project Laboratory
(Same subject as 6.070J)
Prereq: None
U (Fall, Spring)
2-2-2
See description under subject 6.070J. J. Bales

SP.710–SP.715 Special Topics at the Edgerton Center
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

SP.716–SP.720 Special Topics at the Edgerton Center
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Seminars combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per term, covering a different topic each time. Students can take one or all of the seminars. J. K. Vandiver

SP.721J D-Lab: Development
(Same subject as 11.025J)
Subject meets with 11.472J
Prereq: None
U (Fall)
3-2-7 HASS
Issues in international development, appropriate technology and project implementation addressed through lectures, case studies, guest speakers and laboratory exercises. Students form project teams to partner with community organizations in developing countries, and formulate plans for an optional IAP site visit. (Previous field sites include Ghana, Brazil, Honduras and India.) Recitation sections focus on specific project implementation, and include cultural, social, political, environmental and economic overviews of the target countries as well as an introduction to the local languages.
SP.722J D-Lab: Design
(Same subject as 2.722J)
Prereq: 2.670 or permission of the instructor
U (Spring)
3-0-9
Addresses problems faced by underserved communities with a focus on design, experimentation, and prototyping processes. Particular attention placed on constraints faced when designing for developing countries. Multidisciplinary teams work on long-term projects in collaboration with community partners, field practitioners, and experts in relevant fields. Topics covered include design for affordability, manufacture, sustainability, and strategies for working effectively with community partners and customers. Students may continue projects begun in SP.721. Enrollment limited by lottery; must attend first class. A. B. Smith, J. K. Vandiver

SP.723 D-Lab: Disseminating Innovations for the Common Good
Prereq: None
U (Spring)
3-0-6
Focuses on disseminating innovations among underserved communities, especially in developing countries. Students work in teams to complete a term project based on their own Big Idea. Structured around MIT and external competitions; e.g., students enter the MIT IDEAS Competition. Includes an online forum discussion, hands-on learning, student-led case studies, and a final proposal or social-business plan for implementing an innovation. Emphasis on theory, practice, tools and skills related to building partnerships and piloting, financing, implementing, and scaling up a selected innovation for the common good. The practice component is taught via case studies and guest lecturers. No trips are formally associated with the class, but some students elect to pursue a summer implementation of the dissemination of their innovation. Enrollment limited to 30. S. E. Murcott

SP.724 Prototype to Product
Prereq: Permission of instructor
U (Fall)
1-2-3
Can be repeated for credit
Students and teams who have started a project in D-Lab, the IDEAS Competition, Design for Demining, Product Engineering Processes or elsewhere can continue developing projects to be implemented in the field. Topics covered include prototyping techniques, materials selection, design-for-manufacturing, field-testing, and project management. All classwork directly relates to student projects. Students should have an existing project that they wish to advance to the next level. Teams are encouraged to enroll together. Enrollment limited to 15. No listeners. A. Heafitz

SP.725 D-Lab: Health Technologies for the Developing World (New)
Prereq: Permission of instructor
U (Spring)
3-0-6
Provides a multidisciplinary approach to global health technology design through lectures and a major team project based on fieldwork, which involves partnering with community health professionals in Nicaragua. Explores the current state of global health challenges and teaches students how to design medical technologies that address those problems using interactive laboratory modules. Culminates in the creation of a product design solution to address the challenges observed in the field. Travel to Nicaragua during spring break includes additional fee; consult instructor for details. Students may be able to arrange summer research opportunities based on coursework experience. Enrollment limited. J. Gomez-Marquez

SP.731 Edgerton Center Undergraduate Teaching
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
An opportunity for undergraduates to participate in teaching and tutoring Edgerton Center subjects and seminars. Students develop one-on-one teaching skills under the supervision of an Edgerton Center instructor. J. K. Vandiver

SP.732 Edgerton Center Graduate Teaching
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
An opportunity for graduate students to participate in teaching and tutoring Edgerton Center subjects and seminars. Permission of Edgerton Center staff required. Staff

SP.747 Creative Imaging
Prereq: None
U (Spring)
2-1-6
Credit cannot also be received for SP.757
Subject centered around both film and digital photography. Students use chemical darkrooms, scanners, digital printers and cameras, and video capture equipment. Software used includes Adobe Photoshop, Illustrator and Premiere. Subject deals with photography with emphasis on the interplay between classical chemical and digital techniques. Each student is expected to develop a creative imaging term project of their own choice. Intermediate goals are set. T. Mislick, J. K. Vandiver

SP.757 Digital and Darkroom Imaging
Prereq: None
U (Fall)
2-0-4 [P/D/F]
Credit cannot also be received for SP.747
Edgerton Center Seminar. Each student will learn to use both film and digital photography in developing a creative imaging project of his or her own choice. The New Media Center 26-139 will be used to develop facility in applying Photoshop 7.0 to enhance, select and combine images that the student has taken for the project. The darkrooms of the Edgerton Center will be used to develop film for scanning and for chemical enlargement. The digital imaging facilities of the Center include scanners, Macintosh workstations, digital cameras and digital printers. Review of student work will be interspersed with chalk talks and slide and print demonstrations on topics such as aliasing, modes and formats, image compression, and halftone and dye sublimation printing. Each student will be expected to produce a duplicate set of black and white and/or color prints as the project output: one to keep and one for display at the Center. T. Mislick

SP.779 Advanced Toy Product Design
Prereq: 2.00B or permission of instructor
U (Fall, Spring)
1-3-5
A continuation of 2.00B that provides students with an opportunity for design projects in areas of entertainment and play, as well as opportunities in creative product design and community service. Students further develop ideas for new toys that serve clients in the community, and work independently with local sponsors and with experienced mentors on a themed toy design project. Provides opportunity for students to demonstrate creativity and obtain experience in advanced aspects of the product development
process and experience advanced aspects of the product development process, including design aesthetics, detailed design, prototyping, user testing, and design for manufacture. Includes written, visual, and oral communication.

D. Wallace, B. Kudrowitz

SP.782 Digital Video Production: Documentary
Prereq: Permission of instructor
U (Fall) 2-1-3

In-depth introduction to documentary video production that teaches principles of dramatic and visual storytelling; cinematography concepts such as composition, continuity, and camera angles; and technical skills with professional video cameras and microphones. Students videotape activities on campus and interview members of the MIT community to complete video production projects that meet professional standards for sound and image quality. This seminar is for those with serious interests in filmmaking, but no prior video production experience is required. Enrollment limited to 12. No listeners.
V. Ivanova

SP.784 Wheelchair Design in Developing Countries
Prereq: None
U (Spring) 2-2-5

Improve wheelchair technology in developing countries by applying sound engineering practices to create appropriate devices. Lectures focus on wheelchair usage, social stigmas, and manufacturing constraints. Includes lectures by third-world community partners, US wheelchair organizations, and MIT faculty. Multidisciplinary student teams conduct term-long wheelchair projects relating to hardware design, manufacturing optimization, biomechanics modeling, and business plan development. Funded opportunities are available for travel to implement class projects at wheelchair workshops in the field.
A. B. Smith, A. Winter

SP.785 Digital Video Post-Production
Prereq: Permission of instructor
U (Spring) 1-2-6

Introduction to principles of film and video post-production with an emphasis on documentary editing. Student teams of 3-4 complete a video editing project from start to finish, including media logging and capturing, first assembly, paper cut, rough cut, refining through picture lock, sound design and editing, title design, and fine cut. Also covered are video encoding, DVD authoring, and web video streaming. Course-work requires use of software tools such as Final Cut Pro, Soundtrack Pro, Compressor, and DVD Studio Pro at the New Media Center. Individual and group instruction provided as needed. Students must either bring their own original, copyright-cleared video material or use video materials approved by the instructor. Class size is limited.
V. Ivanova

SP.792 X PRIZE Workshop: Grand Challenges in Health Care
(Same subject as ESD.173J, HST.937J)
Prereq: Permission of instructor
G (Spring) 3-0-6

See description under subject ESD.173J.
E. Wagner, D. Newman, F. Murray, K. Zolot, J. Shames, C. Cooney

SP.793 X PRIZE Workshop: Grand Challenges in Energy (New)
(Same subject as ESD.172I)
Prereq: Permission of instructor
G (Fall) 3-0-6

See description under subject ESD.172I.
E. Wagner, D. Newman, F. Murray, K. Zolot, J. Shames, C. Cooney, R. Lester

SP.7UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
SP.7URG Undergraduate Research—Graded
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Undergraduate research opportunities in the Edgerton Center.
J. K. Vandiver

FRESHMAN/ALUMNI SUMMER INTERNSHIP PROGRAM

SP.800 Freshman/Alumni Summer Internship Program
Prereq: None
U (Spring) Units arranged
Prepares freshmen for summer internships in various companies. Includes workshops on leadership skill development, interviewing, communications, negotiation, and dynamics in the workplace. Upon acceptance to the program, students have readings, writings, discussion, and role-playing exercises. Attendance at the workshops is mandatory.
A. Steinberg

SP.801 Freshman/Alumni Summer Internship Program II
Prereq: SP.800
U (Fall) Units arranged
Students who have completed the subject requirements for SP.800 and worked in an approved internship polish their communication skills further by writing reflection papers and giving a formal presentation about their experiences upon their return in the fall.
A. Steinberg

WOMEN'S AND GENDER STUDIES PROGRAM

SP.400 Special Topics in Women's and Gender Studies Seminar
Prereq: None
U (Fall, Spring) 3-0-9 HASS
Can be repeated for credit
Seminar with one-time topics not taught within regular offerings.
Staff

SP.401 Introduction to Women's and Gender Studies
Prereq: None
U (Fall, Spring) 3-0-9 HASS-D, Category 4, CI-H
Drawing on multiple disciplines—such as literature, history, economics, psychology, philosophy, political science, anthropology, media studies and the arts—to examine cultural assumptions about sex, gender, and sexuality. Integrates analysis of current events through student presentations, aiming to increase awareness of contemporary and historical experiences of women, and of the ways sex and gender interact with race, class, nationality, and other social identities. Students are introduced to recent scholarship on gender and its implications for traditional disciplines.
Fall: A. Sur
Spring: A. Walsh
Primary topics of interest include transformations the production industry impacts women’s lives, and how access to the internet and to community and nation, how development affects changes gender and racial identities. Provides introduction to feminist approaches to media studies by drawing from work in feminist film theory, cultural studies, gender and politics, and cyberfeminism.

K. Surkan

SP.417J Black Matters: Introduction to Black Studies (New)
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 4, CI-H

See description under subject 21M.630J.
T. DeFrantz, S. Alexandre, C. Capozzola

SP.427 Women in the Developing World
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

Can be repeated for credit

Study of women and gender in the Middle East and/or North Africa. Interdisciplinary approaches highlight relationships between gender and public policy, economics, art, education, health care, and scientific research. Based on the McMillan-Stewart lecture series; topics vary by term.

Staff

SP.429J Rethinking the Family, Sex, and Gender (New)
(Same subject as 21A.232J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

See description under subject 21A.232J.
H. Paxson

SP.448J Gender and Representation of Asian Women
(Same subject as 21A.470J)
Prereq: None
U (Spring)
3-0-9 HASS

See description under subject 21A.470J.
M. Buyandelger

SP.454J Identity and Difference
(Same subject as 21A.218J)
Prereq: None
U (Spring)
3-0-9 HASS, CI-H

See description under subject 21A.218J.
J. Jackson

SP.459J Women in South Asia from 1800 to Present
(Same subject as 21H.575J)
Prereq: None
U (Fall)
2-0-10 HASS

See description under subject 21H.575J.
H. Roy

SP.461J International Women’s Voices
(Same subject as 21F.022J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS-D, Category 1, CI-H

See description under subject 21F.022J.
M. Resnick

SP.466 Topics in Modern French Literature
(Subject meets with 21F.346)
Prereq: One intermediate subject in French
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Can be repeated for credit

Meets with 21F.346 when the topic has content consistent with the requirements for Women’s Studies subjects.
I. de Courtivron

SP.404 Special Topics in Women’s and Gender Studies
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit

SP.405 Special Topics in Women’s and Gender Studies
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit

Individual supervised work for graduate students who wish to study topics not covered in the regular Women’s and Gender Studies offerings. Before registering for this subject, students must plan a course of study with a member of the Women’s and Gender Studies faculty and secure the Director’s approval. Normal maximum is 6 units; exceptional 9-unit projects occasionally approved.
Staff

SP.406 Sexual and Gender Identities
Prereq: None
U (Spring)
3-0-9 HASS

Introduces scholarly debates about sexual identities, gender identities and expressions, and sexual orientation and its representation in various media. Topics may include lesbian, gay, bisexual, and transgender (LGBT) sexual identities as well as their histories in Western and non-Western cultures; queer theory and theories of identity; the origins of social movements for equality; issues of race and diversity within LGBT communities; questions of visibility and media representation; and the politics of sexual orientation in contemporary American institutions. Materials include secondary readings in history, philosophy and cultural theory as well as novels and plays, films and television programs, community studies, oral histories, and legal cases.

K. Surkan

SP.409 Women and Global Activism in Media and Politics
Prereq: None-U (Spring)
3-0-9 HASS-D, Category 4, CI-H

An interdisciplinary subject that examines questions of feminism, international women’s issues, and globalization through the study of novels, films, critical essays, painting and music. Considers how women redefine the notions of community and nation, how development affects their lives, and how access to the internet and to the production industry impacts women’s lives. Primary topics of interest include transformations of traditional values, social change, gender role distribution, identity formation, migration flows, globalization and development, popular culture, urban life, cyber-culture, activism, and human rights. Enrollment limited to 25 when Writing Tutor is assigned to the class. Otherwise, 18.

A. Sur

SP.414 Gender and Media Studies
Prereq: None
U (Spring)
3-0-9 HASS

Examines representations of race, gender, and sexual identity in the media. Considers issues of authorship, spectatorship, and the ways in which various media (film, television, print journalism, advertising) enable, facilitate, and challenge these social constructions in society. Studies the impact of new media and digital media through analysis of gendered and racialized language and embodiment online in blogs and vlogs, avatars, and in the construction of cyberidentities. Provides introduction to feminist approaches to media studies by drawing from work in feminist film theory, cultural studies, gender and politics, and cyberfeminism.

K. Surkan

SP.417J Black Matters: Introduction to Black Studies (New)
Prereq: None
U (Fall)
3-0-9 HASS-D, Category 4, CI-H

See description under subject 21M.630J.
T. DeFrantz, S. Alexandre, C. Capozzola

SP.427 Women in the Developing World
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

Can be repeated for credit

Study of women and gender in the Middle East and/or North Africa. Interdisciplinary approaches highlight relationships between gender and public policy, economics, art, education, health care, and scientific research. Based on the McMillan-Stewart lecture series; topics vary by term.

Staff

SP.429J Rethinking the Family, Sex, and Gender (New)
(Same subject as 21A.232J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

See description under subject 21A.232J.
H. Paxson

SP.448J Gender and Representation of Asian Women
(Same subject as 21A.470J)
Prereq: None
U (Spring)
3-0-9 HASS

See description under subject 21A.470J.
M. Buyandelger

SP.454J Identity and Difference
(Same subject as 21A.218J)
Prereq: None
U (Spring)
3-0-9 HASS, CI-H

See description under subject 21A.218J.
J. Jackson

SP.459J Women in South Asia from 1800 to Present
(Same subject as 21H.575J)
Prereq: None
U (Fall)
2-0-10 HASS

See description under subject 21H.575J.
H. Roy

SP.461J International Women’s Voices
(Same subject as 21F.022J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS-D, Category 1, CI-H

See description under subject 21F.022J.
M. Resnick

SP.466 Topics in Modern French Literature
(Subject meets with 21F.346)
Prereq: One intermediate subject in French
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Can be repeated for credit

Meets with 21F.346 when the topic has content consistent with the requirements for Women’s Studies subjects.
I. de Courtivron
SP.492 Popular Narrative (Subject meets with 21L.430, CMS.920)  
Prereq: One subject in Literature  
U (Spring)  
3-3-6 HASS  
Can be repeated for credit  
Meets with 21L.430 when the topic has content consistent with the requirements for Women's Studies subjects.  
Staff  

SP.493 Media in Cultural Context (Subject meets with 21L.715, CMS.871)  
Prereq: Two subjects in Literature and/or Comparative Media Studies or permission of instructor  
U (Fall)  
3-3-6 HASS  
Can be repeated for credit  
Meets with 21L.715 when the topic has content consistent with the requirements for Women's Studies subjects. Provides close case study examinations of specific media or media configurations and the larger social, cultural, economic, political, or technological contexts within which they operate. Topics organized around recurring themes in media history, specific genres or movements, specific media, or specific historical moments. Previously taught cross-listed topics include Gendered Genres: Horror and Maternal Melodramas, Girl Culture in Japan, and Exploring Children's Culture. Enrollment limited to 12.  
Staff  

SP.510 Literary Interpretation (Subject meets with 21L.701)  
Prereq: None  
U (Spring)  
3-0-9 HASS  
Can be repeated for credit  
Meets with 21L.701 when the topic has content consistent with the requirements for Women's Studies subjects, such as “Virgina Woolf's Shakespeare”.  
S. Brouillette  

SP.511 Studies in Poetry  
Prereq: Two subjects in Literature  
U (Spring)  
3-0-9 HASS  
Can be repeated for credit  
Meets with 21L.704 when the topic has content consistent with the requirements for Women's Studies subjects such as "Gender and Lyric in the English Renaissance" and "Poetry in the Age of Elizabeth I."  
Staff  

SP.512 Major Authors (Subject meets with 21L.705)  
Prereq: Two subjects in Literature  
U (Fall, Spring)  
3-0-9 HASS  
Can be repeated for credit  
Meets with 21L.705 when the topic has content consistent with the requirements for Women's Studies subjects such as “Willa Cather” and “Morrison and Melville.”  
Fall: J. Picker  
Spring: W. Kelley  

SP.513 Jane Austen (Same subject as 21L.473)  
Prereq: One subject in Literature  
U (Spring)  
3-0-9 HASS  
See description under subject 21L.473.  
R. Perry  

SP.514 Medieval Literature (Subject meets with 21L.460)  
Prereq: None  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Fall)  
3-0-9 HASS  
Meets with 21L.460 when the topic has content consistent with the requirements for Women's Studies subjects such as “Medieval Women's Literature.”  
A. Bahr  

SP.515 Studies in Fiction  
Prereq: Two subjects in Literature  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Spring)  
3-0-9 HASS  
Can be repeated for credit  
Meets with 21L.702 when the topic has content consistent with the requirements for Women's and Gender Studies subjects.  
Staff  

SP.516 Problems in Cultural Interpretation  
Prereq: Two subjects in Literature or permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Spring)  
3-0-9 HASS  
Can be repeated for credit  
Meets with 21L.707 when the topic has content consistent with the requirements for Women's Studies subjects such as “Gender and Ideology in 18th-Century Literature,” “Technobodies,” and “Women Reading, Women Writing.” See description under subject 21L.707.  
Staff  

SP.517 American Authors (Subject meets with 21L.512)  
Prereq: One subject in Literature  
U (Spring)  
3-0-9 HASS  
Meets with 21L.512 when the topic has content consistent with the requirements for Women's Studies subjects such as “American Women Writers.” See 21L.512 for topic description.  
Staff  

SP.518 Race and Identity in American Literature (Same subject as 21L.504)  
Prereq: None  
U (Spring)  
3-0-9 HASS  
See description under subject 21L.504.  
S. Alexandre  

SP.574 Contemporary US Women of Color: Writing and Reading Short Stories (Same subject as 21W.766)  
Prereq: None  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Spring)  
3-0-9 HASS  
See description under subject 21W.766.  
H. Lee  

SP.575 Writing about Race (Same subject as 21W.742)  
Prereq: None  
U (Spring)  
3-0-9 HASS-D, Category 2, CI-H  
See description under subject 21W.742.  
K. Ragusa  

SP.576 Advanced Essay Workshop (Subject meets with 21W.745)  
Prereq: None  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Spring)  
3-0-9 HASS, CI-H  
Meets with 21W.745 when the topic has content consistent with the requirements for Women's Studies subjects such as "Negotiating Identities" and "Writing about Gender."  
R. Faery
Subjects SP.492 to SP.691

SP.591J Traditions in American Concert Dance: Gender and Autobiography
(Same subject as 21M.670J)
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 3, CI-H
See description under subject 21M.670J.
T. DeFrantz

SP.595J Theater and Cultural Diversity in the US
(Same subject as 21M.621J)
Prereq: None
U (Spring)
3-0-9 HASS-D, Category 3
See description under subject 21M.621J.
T. DeFrantz

SP.601J Feminist Political Thought
(Same subject as 17.007J)
Subject meets with 17.006, 24.237
Prereq: None
U (Spring)
3-0-9 HASS
Analyzes theories of gender and politics, especially ideologies of gender and their construction; definitions of public and private spheres; gender issues in citizenship, the development of the welfare state, experiences of war and revolution, class formation, and the politics of sexuality. Graduate students are expected to pursue the subject in greater depth through reading and individual research.
E. Wood

SP.603J Race and Gender in Asian America
(Same subject as 21F.069J, 21H.153J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
See description under subject 21F.069J.
E. Teng

SP.607J Gender and the Law in US History
(Same subject as 21H.225J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
See description under subject 21H.225J.
C. Capozzola

SP.610J Gender and Work: From the Middle Ages to the Contemporary World
(Same subject as 21H.927J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
2-0-10 HASS
See description under subject 21H.927J.
Staff

SP.621J Violence, Human Rights, and Justice
(Same subject as 21A.225J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS, CI-H
See description under subject 21A.225J.
E. C. James

SP.622J Dilemmas in Biomedical Ethics: Playing God or Doing Good?
(Same subject as 21A.216J)
Prereq: None
U (Fall)
3-0-9 HASS, CI-H
See description under subject 21A.216J.
E. C. James

SP.640J The Science of Race, Sex, and Gender
(Same subject as STS.046J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS, CI-H
Examines the role of science and medicine in the origins and evolution of the concepts of race, sex, and gender from the seventeenth century to the present. Focus on how biological, anthropological, and medical concepts intersect with social, cultural, and political ideas about racial, sexual, and gender difference in the U.S. and globally. Approach is historical and comparative across disciplines emphasizing the different modes of explanation and use of evidence in each field.
E. C. James

SP.650J Psychology of Gender and Race
(Same subject as 9.75J)
Prereq: None
U (Fall, Spring)
3-0-9 HASS
See description under subject 9.75J.
C. Kapungu

SP.680 The Economic History of Work and the Family
Prereq: None
G (Fall)
3-0-9
Explores the changing map of the public and the private in pre-industrial and modern societies and examines how that map affected men's and women's production and consumption of goods and leisure. The reproductive strategies of women, either in conjunction with or in opposition to their families, is another major theme. Subject asks how an ideal of the "domestic" arose in the early modern west, and to what extent did it limit the economic position of women; and how has that idea been challenged, and with what success in the post-industrial period. Focuses on western Europe since the Middle Ages and on the United States, but also examines how these issues have played themselves out in non-Western cultures. Graduate students are expected to pursue the subject in greater depth through reading and individual research.
A. McCants

SP.690 Workshop for Dissertation Writers in Women's and Gender Studies
Prereq: Must apply to the Graduate Consortium in Women's Studies
G (Fall, Spring)
3-0-9
Can be repeated for credit
Addresses the main challenges faced by dissertation writers: isolation, writing schedules, and cogent arguments. Opportunity for members to exchange ideas and experiences, learn general principles of academic argument, and receive feedback. Open to graduate students in all phases of dissertation writing. Meets bi-weekly, spans fall and spring terms. Enrollment limited to 10.
Consult Graduate Consortium in Women's Studies

SP.691 Studies in Women's Life Narratives
Prereq: Must apply to the Graduate Consortium in Women's Studies
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Close examination of women's life narratives. Syllabi vary depending on instructors. Enrollment limited to 10.
Information: Graduate Consortium in Women's Studies
SP.692 Seminar in Feminist Issues
Prereq: Must apply to the Graduate Consortium in Women's Studies
G (Fall)
3-0-9
Can be repeated for credit
Syllabi vary depending on instructors. Enrollment limited to 10.
Information: Graduate Consortium in Women's Studies

SP.693 Feminist Inquiry: Strategies for Effective Scholarship
Prereq: Must apply to the Graduate Consortium in Women's Studies
G (Fall)
3-0-9
Can be repeated for credit
Investigates theories and practices of feminist inquiry across a range of disciplines. Feminist research involves rethinking disciplinary assumptions and methodologies, developing new understandings of what counts as knowledge, seeking alternative ways of understanding the origins of problems/issues, formulating new ways of asking questions and redefining the relationship between subjects and objects of study. Focus on methodology, i.e., the theory and analysis of how research should proceed. Special attention to epistemological issues—pre-suppositions about the nature of knowledge. What makes research distinctively feminist lies in the complex connections between epistemologies, methodologies and research methods. Explore how these connections are formed in the traditional disciplines and raise questions about why they are inadequate and/or problematic for feminist inquiry and what, specifically, are the feminist critiques of these intersections.
Information: Graduate Program in Women's Studies

SP.694 Issues of Representation: Feminist Theory
Prereq: Application to the Graduate Consortium in Women's Studies
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Syllabi vary depending on instructors.
Consult Graduate Program in Women's Studies

SP.695 Interdisciplinary Area Studies in Feminist Theories
Prereq: Must apply to the Graduate Consortium in Women's Studies
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9
Can be repeated for credit
Syllabi vary depending on instructors.
Information: Graduate Consortium in Women's Studies

SP.4UR Women's Studies Undergraduate Research
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

SP.4URG Women's Studies Undergraduate Research
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Undergraduate Research opportunities in the Women's Studies Program.
Staff
STs.006] Bioethics  
(Same subject as 24.06)  
Prereq: None  
U (Spring)  
3-0-9 HASS-D, Category 2, CI-H  
See description under subject 24.06.  
C. Hare, D. Jones  

STs.010 Neuroscience and Society  
Prereq: None  
U (Spring)  
3-0-9 HASS-D, Category 4, CI-H  
Explores social relevance of neuroscience,  
considering how emerging areas of brain  
research reflect and reshape social attitudes  
and agendas. Topics include brain imaging and  
popular media; neuroscience of empathy, trust,  
and moral reasoning; new fields of neuroeco-  
nomics and neuromarketing; ethical implica-  
tions of neurotechnologies such as cognitive  
enhancement pharmaceuticals; neuroscience in  
the courtroom; and neuroscientific recasting of  
social problems such as addiction and violence.  
Guest lectures by neuroscientists, class discus-  
sion, and weekly readings in neuroscience,  
popular media, and science studies.  
N. Schüll  

STs.011 American Science: Ethical Conflicts and  
Political Choices  
Prereq: None  
U (Spring)  
3-0-9 HASS-D, Category 2  
Explores the changing roles, ethical conflicts,  
and public perceptions of science and scientists  
in American society from World War II to the  
present. Studies specific historical episodes  
focusing on debates between scientists and the  
contextual factors influencing their opinions  
and decisions. Topics include the atomic bomb  
project, environmental controversies, the Chal-  
lenger disaster, biomedical research, genetic  
engineering, (mis)use of human subjects, scien-  
tific misconduct and whistleblowing.  
Staff  

STs.015 Mapping Controversies: Preparing  
Scientists and Engineers for a More Complex  
World  
Prereq: None  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: U (Spring)  
3-0-9 HASS  
Introduction to the complicated universe of  
scientific and technical research. Account for  
and map techno-scientific controversies which  
are rife with uncertainties and dilemmas. Con-  
troversies studied include projects of advanced  
technical expertise as well as projects entangled  
with legal, moral, economic and social ques-  
tions. Learn how to describe these contentious  
arenas and present findings by creating webs-  
ites available to the general public. Some sites  
may be selected to participate in an interna-  
tional student competition. Enrollment limited to 25.  
V. Lepinay  

ADVANCED UNDERGRADUATE SUBJECTS  

STs.022 Technology in History (New)  
Prereq: None  
U (Spring)  
3-0-9 HASS  
Covers theories of the interactions between  
historical and technological change; rela-  
tions between the histories of science and of  
technology; purported turning points such  
as the Neolithic, Industrial, and Information  
Revolutions; case studies from a wide range of  
times and places; and connections across time  
and space. Lectures supplemented by student  
presentations. Frequent writing, rewriting, and  
small group work.  
R. H. Williams  

STs.025 Making the Modern World: The  
Industrial Revolution in Global Perspective  
(New)  
Prereq: None  
Acad Year 2009–2010: U (Fall)  
Acad Year 2010–2011: Not offered  
3-0-9 HASS  
Global survey of the great transformation in  
history known as the “Industrial Revolution.”  
Topics include origins of mechanized produc-
tion, the factory system, steam propulsion, electrification, mass communications, mass production and automation. Emphasis on the transfer of technology and its many adaptations around the world. Countries treated include Great Britain, France, Germany, the US, Sweden, Russia, Japan, China, and India. Includes brief reflection papers and a final paper.

M. R. Smith

STS.029J The Civil War and Reconstruction
(Subject as 21H.116)
(Subject meets with STS.423)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
See description under subject 21H.116.

M. R. Smith

STS.032 Energy, Environment, and Society (New)
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 HASS
Examines national and global energy debates, namely energy security, climate change, and energy access. Explores technological, market, environmental, cultural and political “fixes” to the energy question, as well as a wide variety of energy forms and stakeholders. Evaluates development, nuclear security, environment ethics, and conflicts between energy and food security. Includes debates, presentations, group projects (in class and in the Cambridge community), grant-writing, and individual written assignments.

C. Mavhunga

STS.034 Science Communication: A Practical Guide (New)
Prereq: None
U (Spring)
3-0-9 HASS, CI-H
Develops students’ abilities to communicate science effectively to non-specialist audiences in a variety of media. Emphasizes the elements of effective speaking and writing and the art of storytelling. Students study examples of science communication in journalism, broadcasting, museums and new media, and develop their skills through classroom exercises, speaking and writing assignments. Students undertake a practical project in science communication through the Cambridge Science Festival, organized by the MIT Museum.

J. Durant

STS.039 Technology and Imagination
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS
Explores the meanings of “technology” and “imagination,” the ways that technologies stimulate imagination, and the ways that imagination stimulates technological development and use. Draws upon the history of technology and science, literary and cultural theory, and imaginative writing. Readings range from Romantic poets to recent novels. Topics include scientific instrumentation, utopianism, and space travel. Students are encouraged to relate class materials to popular culture, including visual and online media. Enrollment limited to 25.

R. H. Williams

STS.042J Einstein, Oppenheimer, Feynman: Physics in the 20th Century
(Subject as 8.225j)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
Explores the changing roles of physics and physicists during the 20th century. Topics range from relativity theory and quantum mechanics to high-energy physics and cosmology. Examines the development of modern physics within shifting institutional, cultural, and political contexts, such as physics in Imperial Britain, Nazi Germany, US efforts during World War II, and physicists’ roles during the Cold War. Enrollment limited.

D. I. Kaiser

STS.043 Technology and Self: Science, Technology, and Memoir
(Subject meets with STS.443)
Prereq: Writing sample
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
2-0-7 HASS
Focuses on the memoir as a window onto the relationship of the scientist, engineer, and technologist to his or her work. Studies the subjective side of technology and the social and psychological dimensions of technological change. Students write about specific objects and their role in their lives—memoir fragments. Readings concern child development theory and the role of technology in development. Explores the connection between material culture, identity, cognitive and emotional development.

S. Turkle

STS.044 Technology and Self: Things and Thinking
(Subject meets with STS.444)
Prereq: None
U (Spring)
3-0-9 HASS
Explores emotional and intellectual impact of objects. The growing literature on cognition and “things” cuts across anthropology, history, social theory, literature, sociology, and psychology and is of great relevance to science students. Examines the range of theories, from Mary Douglas in anthropology to D.W. Winnicott in psychoanalytic thinking, that underlies “thing” or “object” analysis.

S. Turkle

STS.045 Technology and Experience
Prereq: None
U (Spring)
3-0-9 HASS
Introduction to the “inner history” of technology—how it affects intimate aspects of human experience from sociological, psychological and anthropological perspectives. Topics include how the internet transforms our experience of time, space, privacy, and social engagement; how entertainment media affects attention, emotion, and creativity; how medical technologies alter the experience of illness, reproduction, and mortality; how pharmaceuticals reshape identity, mood, pain, and pleasure. In-class discussion of readings, short written assignments, final project.

S. Turkle

STS.046J The Science of Race, Sex, and Gender
(Subject as SP.640j)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2001: U (Fall)
3-0-9 HASS, CI-H
See description under subject SP.640j.

A. Sur

STS.048 African Americans in Science, Technology, and Medicine
Prereq: None
U (Spring)
3-0-9 HASS
A survey of the contributions of African Americans to science, technology, and medicine from colonial times to the present. Explores the impact of concepts, trends, and developments in science, technology, and medicine on the lives of African Americans. Examples include the eugenics movement, the Tuskegee Syphilis Experi-
ment, the debate surrounding racial inheritance, and IQ testing.

K. Manning

STS.050 The History of MIT (New)
Prereq: None
U (Spring)
3-0-9 HASS

Examines the history of MIT through the lens of the broader history of science and technology, and vice versa. Covers pre-history and founding (1861) to the present. Topics include William Barton Rogers; educational philosophy; biographies of MIT students and professors; campus, intellectual and organizational development; the role of science; changing laboratories and practices; and MIT’s relationship with Boston, the federal government, and industry. Guest lecturers discuss recent history. Includes short papers, presentations, and final paper.

D. Mindell, M. R. Smith

STS.051 Finance: Culture, Technologies, and Markets
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

Introduction to a rapidly growing literature in new economic sociology, social studies of finance, and an anthropology of markets. The more recent interest for these modalities has cast new light on the role of technologies, theories, and models in the creation of new markets. Review and discussion of these new studies with economics on the question of technologies in markets. Enrollment limited to 25.

V. Lepinay

STS.056 Science and the Cinema: Experiments on Film (New)
Prereq: None
U (Spring)
2-1-9 HASS

Examines the linked histories of science and cinema starting from 1895. Introduces themes from the fields of STS and media studies. Mandatory weekly screening sessions alternate among feature-length films, series of short films and direct engagement with technologies of filmic production, screening and visual analysis. Some screening materials available for out-of-class viewing. Assignments include short papers, a collaborative media project, midterm and final. Evaluation includes attendance at screenings and participation in collaborative assignments and classroom discussion. Limited to 40.

H. R. Shell

STS.060J The Anthropology of Biology
(Same subject as 21A.355J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

See description under subject 21A.355J.

S. Helmreich

STS.062J Drugs, Politics, and Culture
(Same subject as 21A.344J)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS

See description under subject 21A.344J.

Staff

STS.064J DV Lab: Documenting Science through Video and New Media (New)
(Same subject at 21A.339J)
Prereq: None
U (Spring)
3-3-6 HASS

See description under subject 21A.339J.

C. Wolley, C. Boebel

STS.065J The Anthropology of Sound
(Same subject as 21A.360J)
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 HASS

See description under subject 21A.360J.

S. Helmreich

STS.072J Nuclear Forces and Missile Defenses
(Same subject as 17.477J)
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 HASS

See description under subject 17.477J.

T. Postol, S. Ghoshroy

STS.073 Technology and Politics in the Acquisition of Military Systems
(Same subject meets with STS.421)
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
3-0-9 HASS

Examines the technical factors that make weapons and military forces effective and the increasingly countervailing influence of political, economic, and bureaucratic forces that often lead to weapons of both greater cost and lower effectiveness. Examines the challenges in evaluating technology maturity. Discusses defense spending and the role of the military-industrial complex. Case studies include the F-22 Raptor; MX long-range ballistic missile; missile defense systems, such as the Airborne Laser; the Future Combat System. Students choose, analyze, and report on own case studies.

T. Postol, S. Ghoshroy

STS.074J Art, Craft, Science
(Same subject as 21A.370J)
Prereq: None
U (Fall)
3-0-9 HASS

See description under subject 21A.370J.

S. Roosth

STS.075J Technology and Culture
(Same subject as 21A.340J)
Prereq: None
U (Fall)
3-0-9 HASS

See description under subject 21A.340J.

K. Downes

STS.076J Technology and Policy of Weapons Systems
(Same subject as 17.477J)
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
3-0-9 HASS

Examines in detail the technology of nuclear weapons systems. Topics include nuclear weapons design, effects, targeting, and delivery; ballistic and air breathing missile propulsion and guidance; communications and early warning techniques and systems; and anti-missile, air, and submarine systems. Combines the discussion of technical materials with the national security policy issues raised by the capabilities of these technologies. Considers security issues from the distinct and often conflicting perspectives of technologists, military planners, and political leaders. Subject fulfills the undergraduate public policy requirement in the Political Science major and minor.

T. Postol

STS.082J Science, Technology, and Public Policy
(Same subject as 17.309J)
Prereq: None
Acad Year 2009–2010: U (Fall)
Acad Year 2010–2011: Not offered
4-0-8 HASS, CI-H

See description under subject 17.309J.

K. Oye
STS.085 Ethics and the Law on the Electronic Frontier
(Subject meets with 6.805, STS.487)
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS
Studies the growth of computer and communications technology and the new legal and ethical challenges that reflect tensions between individual rights and societal needs. Topics include computer crime; intellectual property restrictions on software; encryption, privacy, and national security; academic freedom and free speech. Students meet and question technologists, activists, law enforcement agents, journalists, and legal experts. Extensive use of the internet for readings and other materials.
6.805 meets with STS.085 but does not carry HASS credit. 6.805 may be used as an Engineering Concentration Elective. Enrollment limited.
H. Abelson, M. Fischer, D. Weitzner

STS.087 Biography in Science
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Spring)
3-0-9 HASS
An examination of biography as a literary genre to be employed in the history of science. The use of biography in different historical periods to illuminate aspects of the development of science. A critical analysis of autobiography, archival sources, and the oral tradition as materials in the construction of biographies of scientists. Published biographies of scientists constitute the major reading, but attention is given to unpublished biographical sources as well. Comparison is drawn between biography as a literary form in the history of science and in other disciplines.
K. Manning

STS.089 Wealth, Environment, and Health in Africa
Prereq: None
U (Spring)
3-0-9 HASS
Examines how villagers in rural and urban Africa talk about and connect issues of wealth, environment, and health. Considers the health and wealth functions of the environment; in particular, medicinal, nutritional, agricultural, pastoral, and ecological uses of the land. Emphasis placed on the interaction between indigenous knowledge and western science and technology in specific case studies. Course designed to enable students to integrate village dynamics in the design and implementation of development, public health, and conservation projects.
C. Mavhunga

Special Topics

STS.091 Capstone Seminar in STS Studies I
Prereq: One STS HASS-D subject or permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: U (Fall)
2-0-7 HASS
Analysis of current events and issues from the perspective of STS studies. Read classic works in STS; frequent short writing assignments; discussions and oral presentations; independently defined research project.
Staff

STS.092 Capstone Seminar in STS Studies II
Prereq: One STS HASS-D subject or permission of instructor
U (Spring)
2-0-7 HASS
Analysis of current events and issues from the perspective of STS studies. Read classic works in STS; frequent short writing assignments; discussions and oral presentations; independently defined research project.
N. Schüll

STS.UR Undergraduate Research
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

STS.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Undergraduate research opportunities in the STS Program.
Staff

STS.095, STS.096 Special Topics in Science, Technology, and Society
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
For students who wish to pursue special studies or projects with a member of the Program in Science, Technology, and Society.
Staff

STS.ThT Undergraduate Thesis Tutorial
Prereq: None
U (Fall, Spring)
1-0-5
Can be repeated for credit
Definition and early-stage work on thesis project leading to STS.ThU. Taken during first term of student’s two-term commitment to thesis project. Student works closely with STS faculty tutor. Required of all candidates for an STS degree.
Staff

STS.ThU Undergraduate Thesis
Prereq: STS.ThT
U (Fall, Spring)
Units arranged
Can be repeated for credit
Completion of work of the senior major thesis under the supervision of a faculty tutor. Includes gathering materials, preparing draft chapters, giving an oral presentation of thesis progress to faculty evaluators early in the term, and writing and revising the final text. Students meet at the end of the term with faculty evaluators to discuss the successes and limitations of the project. Required of all candidates for an STS degree.
Staff

GRADUATE SUBJECTS

Required Introductory Subjects

STS.210J Theories and Methods in the Study of History
(Same subject as 21H.991J)
Prereq: Permission of instructor
G (Fall)
3-0-9
See description under subject 21H.991J.
J. Ravel

STS.250J Social Theory and Analysis
(Same subject as 21A.750J)
Prereq: None
G (Fall)
3-0-9
See description under subject 21A.750J.
M. Fischer
Foundation Subjects

STS.310 History of Science
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Intensive reading and analysis of key works in the history and historiography of science. Introduces students to basic interpretive issues, bibliographic sources, and professional standards. Topics change from year to year.

D. I. Kaiser

STS.320J Environmental Conflict and Social Change
(Same subject as 21A.800J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 21A.800J.
C. Wolley

STS.330J History and Anthropology of Medicine and Biology
(Same subject as 21A.830J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Explores recent historical and anthropological approaches to the study of medicine and biology. Topics might include interaction of disease and society; science, colonialism, and international health; impact of new technologies on medicine and the life sciences; neuroscience and psychiatry; race, biology and medicine. Specific emphasis varies from year to year.

D. Jones, S. Helmreich

STS.340 Introduction to the History of Technology
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9 H-LEVEL Grad Credit

Introduction to the consideration of technology as the outcome of particular technical, historical, cultural, and political efforts, especially in the United States during the 19th and 20th centuries. Topics include industrialization of production and consumption, development of engineering professions, the emergence of management and its role in shaping technological forms, the technological construction of gender roles, and the relationship between humans and machines.

R. H. Williams

STS.340J Ethnography
(Same subject as 21A.820J)
Prereq: Permission of instructor; Coreq: 21A.750J
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

Practicum-style course in anthropological methods of ethnographic fieldwork and writing. Depending on student experience in ethnographic reading and practice, subject combines reading ethnographies in anthropological and science studies with formulating and pursuing ethnographic work in local labs, companies, or other sites. Preference to HASTS, CMS, HTC and Sloan graduate students.

M. Fischer

STS.390 Research Seminar in Science, Technology, and Society
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Designed to prepare students to write a piece of original scholarship in historical or social studies of science and technology. Students select a research topic and conduct preliminary research (including identifying potential primary sources, data, and appropriate methodology) before the term begins. Students practice crafting constructive criticism of their peers' work-in-progress. Students complete an original article of publishable quality by the conclusion of the seminar.

H. R. Shell

Advanced Seminars

STS.401J Qualitative Research Methods
(Same subject as 15.349J, 21A.760J)
Prereq: None
G (Spring)
3-6-3

See description under subject 21A.760J.
S. Silbey, E. C. James

STS.410J Reading Seminar in American History, 1877 to the Present
(Same subject as 21H.952J)
Prereq: STS.210J/21H.991J
Acad Year 2009–2010: G (Fall)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

See description under subject 21H.952J.
M. Jacobs

STS.415J Nature, Environment, and Empire
(Same subject as 21H.968J)
Prereq: 21H.991J/STS.210J
Acad Year 2009–2010: G (Spring)
Acad Year 2010–2011: Not offered
3-0-9 H-LEVEL Grad Credit

See description under subject 21H.968J.
H. Ritvo

STS.419 Global Issues in Science, Technology and Society
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Going beyond issues of brain drain and brain circulation, explores how contemporary science and technology innovations look from, and are being created in, parts of the world other than the US and Europe. Examines new forms of science and technology institutions, harmonization and intellectual property constraints, and distributed knowledge. Discusses MIT's role in global STS issues and challenges students to think about how they can effectively apply their expertise in their home countries. Open to upperclassmen with permission of instructor.

M. Fischer

STS.421 Technology and Politics in the Acquisition of Military Systems
(Subject meets with STS.073)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9

Examines the technical factors that make weapons and military forces effective and the
increasingly countervailing influence of political, economic, and bureaucratic forces that often lead to weapons of both greater cost and lower effectiveness. Examines the challenges in evaluating technology maturity. Discusses defense spending and the role of the military-industrial complex. Case studies of weapon systems include the F-22 Raptor; MX long-range ballistic missile; the B-2 strategic bomber; missile defense systems from the 1980s to the present; laser weapons, including the mid-infrared laser (MIRACL), space based (SBL) and the airborne laser (ABL) systems; the future Combat System; and the Bradley fighting vehicle. Students choose, analyze, and report on own case studies.

T. Postol, S. Ghoshroy

**STS.423 Technology in the Civil War Era**  
(Subject meets with 21H.116J, STS.029J)  
Prereq: Permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Fall)  
3-0-9 H-LEVEL Grad Credit

A broad-ranging introduction to the American Civil War that uses technology and technological change as the primary units of analysis. Particular emphasis placed on the industrialization of warfare and its larger impact in the postwar period. Seminar organized around weekly readings. Topics include transportation (rail and wagon), communications (telegraphy), manufacturing (armaments, clothing, shoes, drugs), food production (grains and canned goods), battlefield surgery and medical care.

M. R. Smith

**STS.429 Food and Power in the Twentieth Century**  
Prereq: STS.210, 21H.991, or permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Spring)  
3-0-9 H-LEVEL Grad Credit

Historical analysis of food production, processing, and consumption in America. Emphasis on the social and technical practices of raising crops and livestock; efforts to preserve as well as create new foods; the industrialization of food; the role of ethnicity and gender in consumption patterns; the relation between food supply and the state; the historical and cultural context of eating. STS.428 strongly recommended as a prerequisite, but not required.

D. Fitzgerald

**STS.433 Technology, War, and the American Experience: 1650–1950**  
Prereq: Permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Spring)  
3-0-9 H-LEVEL Grad Credit

Analyzes the development, deployment, and impacts of technology in warfare, focusing primarily on American military affairs from the industrial revolution to the post-World War II period. Also explores how and why the military played a role in American industrialization and influenced the larger economy and society, taking into consideration current discussions among political economists and historians. Open to upperclassmen with permission of instructor.

M. R. Smith

**STS.434 Firearms in Nonwestern Society: When Technology Travels**  
Prereq: None  
Acad Year 2009–2010: G (Spring)  
Acad Year 2010–2011: Not offered  
3-0-9

Explores what happens when technology travels beyond the users for which it was designed into the worlds of unintended users. Follows the itineraries of guns from foundries in Europe and the US into Africa, Asia, Latin America, and the Pacific. Examines how local people inscribe guns with new meanings and uses, (try to) redesign them, or build new versions of them. Covers the whole range of different generations of firearms, from the matchlock to the AK-47, paying attention to how far original design shapes new mappings of meaning, uses, and materiality.

C. Mavhunga

**STS.435 Nuclear Forces and Missile Defenses**  
(Same subject as 17.476J)  
(Subject meets with 17.475J, STS.072J)  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit

See description under subject 17.476J.

T. Postol

**STS.436 Cold War Science**  
Prereq: None  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Fall)  
3-0-9

Examines the history and legacy of the Cold War on American science. Explores scientists' new political roles after World War II, ranging from elite policy makers in the nuclear age to victims of domestic anti Communism. Also examines the changing institutions in which the physical sciences and social sciences were conducted during the postwar decades, investigating possible epistemic effects on forms of knowledge. Subject closes by considering the place of science in the post-Cold War era. Open to undergraduates with permission.

D. I. Kaiser

**STS.443 Technology and Self: Science, Technology, and Memoir**  
(Subject meets with STS.043)  
Prereq: Permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Fall)  
2-0-7 H-LEVEL Grad Credit

**STS.444 Technology and Self: Things and Thinking**  
(Subject meets with STS.044)  
Prereq: Permission of instructor  
G (Spring)  
2-0-7 H-LEVEL Grad Credit

Explores aspects of this topic in conjunction with ongoing activities of the MIT Initiative on Technology and Self, which looks at the social and psychological dimensions of our increasingly intimate relationship with technology. These may include seminars with psychologists and psychiatrists on child and adult clinical cases, the study of the way objects carry ideas, and the ways in which robotics, psychopharmacology, and genomics affect thinking about mind. Graduate students complete additional assignments.

S. Turkle

**STS.445 Technologies for Creative Learning**  
(Same subject as MAS.714J)  
Prereq: Permission of instructor  
G (Fall)  
2-0-7 H-LEVEL Grad Credit

See description under subject MAS.714J.

M. Resnick

**STS.447 Relational Machines**  
(Same subject as MAS.751J)  
Prereq: Permission of instructor  
Acad Year 2009–2010: Not offered  
Acad Year 2010–2011: G (Spring)  
2-0-7 H-LEVEL Grad Credit

See description under subject MAS.751J.

C. Breazeal, S. Turkle
STS.449 Introduction to Global Medicine: Biosciences, Technologies, Disparities, Strategies
(Same subject as HST.934J)
Prereq: None
G (Spring)
2-0-1 [P/D/F]
See description under subject HST.934J.
B. J. Good, M. D. Good, M. M. Fischer, D. Jones

STS.454 Science and Technology in the Museum Environment (New)
Prereq: None
G (Fall)
3-0-9
Examines the ways museums preserve the material culture of science and technology and present it distinctively to a mass audience. Focuses on challenges and opportunities of preserving and presenting science and technology in the museum environment. Students review recent work in museum studies as it relates specifically to science, medicine, and technology; review a major gallery or exhibition locally; and have an opportunity to participate in a collections-communications-related research project in the MIT Museum.
J. Durant

STS.458 Public Understanding of Science: Critical Issues
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Reviews critical issues in the public understanding of science, including what influence the public should have on scientific matters. Assesses practical efforts to promote understanding in the context of recent calls for the better framing of science in the public arena, and the proliferation of Web 2.0 initiatives, such as science blogs. Combines critical literature reviews, visiting lectures and experimental projects. Links with the work of a task group that is investigating options for an MIT Initiative in Public Engagement with Science and Technology. Students track the progress of the task group, and draft their own recommendations for its consideration.
J. Durant

STS.461 Integrating Doctoral Seminar on Emerging Technologies
(Same subject as 17.312J, ESD.85J)
Prereq: Permission of instructor
G (Spring)
2-0-7 H-LEVEL Grad Credit
See description under subject ESD.85J.
K. Oye

STS.462 Social and Political Implications of Technology
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9
Historical and contemporary studies are used to explore the interaction of technology with social and political values. Emphasis on how technological devices, structures, and systems influence the organization of society and the behavior of its members. Examples drawn from the technologies of war, transportation, communication, production, and reproduction.
M. R. Smith

STS.464 Technology and the Literary Imagination
Prereq: None
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
3-0-9
The industrial transformation of 19th- and 20th-century Western society and culture as depicted in imaginative literature (chiefly Anglo-American). Special emphasis on the role of technology and its emergence as a pivotal word and concept.
R. H. Williams

STS.468 Social Studies of Neuroscience
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Explores how contemporary neuroscience lends itself to new understandings of society and new kinds of intervention in social domains such as education, consumption, and law. Topics include neuroimaging, neuroeconomics, neuromarketing, neuroethics, neuropsychology, neuropsychopharmacology, and the neuroscientific recasting of social problems such as addiction and learning disabilities. Specific areas of focus will be chosen according to student interests. Evaluates different research methods and analytical frameworks for studying the emergence and social effects of new knowledge in neuroscience.
N. Schüll

STS.471 Engineering Apollo: The Moon Project as a Complex System
(Same subject as 16.895J, ESD.30J)
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Spring)
4-0-8 H-LEVEL Grad Credit
A detailed technical and historical exploration of the Apollo project to fly humans to the moon and return them safely to earth as an example of a complex engineering system. Emphasis is on how the systems worked, the technical and social processes that produced them, mission operations, and historical significance. Guest lectures by MIT-affiliated engineers who contributed to and participated in the Apollo missions. Students work in teams on a final project analyzing an aspect of the historical project to articulate and synthesize ideas in engineering systems.
D. Mindell, L. R. Young

STS.472 Formalisms
Prereq: Permission of instructor
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Explores how contemporary neuroscience lends itself to new understandings of society and new kinds of intervention in social domains such as education, consumption, and law. Topics include neuroimaging, neuroeconomics, neuromarketing, neuroethics, neuropsychology, neuropsychopharmacology, and the neuroscientific recasting of social problems such as addiction and learning disabilities. Specific areas of focus will be chosen according to student interests. Evaluates different research methods and analytical frameworks for studying the emergence and social effects of new knowledge in neuroscience.
N. Schüll

STS.477 Writing: Science, Technology, and Society
(Same subject as 21W.820J)
Prereq: 21H.991J
Acad Year 2009–2010: Not offered
Acad Year 2010–2011: G (Fall)
3-0-9 H-LEVEL Grad Credit
Examination of different “voices” used to consider issues of scientific, technological, and social concern. Students write frequently and choose among a variety of non-fiction forms: historical writing, social analysis, political criticism, and policy reports. Instruction in expressing ideas clearly and in organizing a thesis-length work.
Reading and writing on three case studies drawn from the history of science; the cultural study of technology and science; and policy issues.

K. Manning

STS.482] Science, Technology, and Public Policy  
(Same subject as 17.310J, ESD.103J)  
Prereq: Permission of instructor  
G (Fall)  
4-0-8 H-LEVEL Grad Credit  
See description under subject 17.310J.  
K. Oye

STS.486 Bridging the Digital Divide: Information Technology and Development  
Prereq: None  
G (Spring)  
3-0-9  
Information technology (IT) is intended to alleviate poverty, help poor people meet fundamental needs, rectify injustices, reduce corruption, and enable citizens of developing countries to assert their fundamental rights. But no agreed-upon theoretical framework justifies this enthusiasm, and a number of critiques have emerged. Equally important, there are virtually no empirical studies of the effectiveness of introducing sophisticated information technologies into developing countries. First half of subject examines theoretical arguments, pro and con, about IT for development. Second half focuses on case studies, primarily from South Asia. Open to undergraduates with permission.  
K. Keniston

STS.487 Ethics and the Law on the Electronic Frontier  
(Subject meets with 6.805, STS.085)  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Studies the growth of computer and communications technology and the new legal and ethical challenges that reflect tensions between individual rights and societal needs. Topics include computer crime; intellectual property restrictions on software; encryption, privacy, and national security; academic freedom and free speech. Students meet and question technologists, activists, law enforcement agents, journalists, and legal experts. Extensive use of the internet for readings and other materials. Enrollment limited.  
H. Abelson, M. Fischer, D. Weitzner

STS.800 Teaching Science, Technology and Society (New)  
Prereq: None  
G (Fall, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit  
For qualified graduate students serving as either a teaching assistant or instructor for subjects in History, Anthropology, or Science, Technology and Society. Enrollment limited by availability of suitable teaching assignments.  
Staff

Research

STS.901–910 Advanced Topics in Science, Technology, and Society  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit  
For students who wish to pursue special studies or projects at an advanced level with a member of the Program in Science, Technology, and Society.  
Staff

STS.ThG Graduate Thesis  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit  
Program of graduate research leading to the writing of a PhD thesis, to be arranged by the student with an appropriate MIT faculty member, who is the thesis supervisor.  
Staff
### Bachelor of Science in Science, Technology, and Society/Double Major/ Course STS (1)

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [three subjects can be satisfied by subjects in the Departmental Program]</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td>17</td>
</tr>
</tbody>
</table>

**Communication Requirement**
The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**

<table>
<thead>
<tr>
<th>Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Subjects</strong></td>
<td>39</td>
</tr>
<tr>
<td>One STS HASS-D subject of at least 12 units</td>
<td></td>
</tr>
<tr>
<td><strong>STS.091</strong> Capstone Seminar in STS Studies I, 9, HASS, CI-M</td>
<td>9</td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td><strong>STS.092</strong> Capstone Seminar in STS Studies II, 9, HASS, CI-M</td>
<td>9</td>
</tr>
<tr>
<td><strong>STS.ThT</strong> Undergraduate Thesis Tutorial, 6</td>
<td>6</td>
</tr>
<tr>
<td><strong>STS.ThU</strong> Undergraduate Thesis, 12, CI-M</td>
<td>12</td>
</tr>
<tr>
<td><strong>Restricted Electives</strong></td>
<td>90–120</td>
</tr>
<tr>
<td>A coherent group of six elective subjects in STS.</td>
<td></td>
</tr>
<tr>
<td>Four related subjects in humanities, arts, and social sciences (three of which can be satisfied by HASS GIRs).</td>
<td></td>
</tr>
<tr>
<td><strong>Departmental Program Units That Also Satisfy the GIRs</strong></td>
<td>(30)</td>
</tr>
<tr>
<td><strong>Unrestricted Electives</strong></td>
<td>48–81</td>
</tr>
</tbody>
</table>

**Total Units Beyond the GIRs Required for SB Degree**

- No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

**Notes**

*Prerequisites and corequisites are listed in the subject description.

The full major in Science, Technology, and Society (STS) may be pursued only as a second major program in conjunction with another degree program in a field of engineering or science.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
Inventions and Patents
(Offered under: 3.172, 6.901, 16.652)
Prereq: 14.02
U (Fall)
3-0-6
History of private and public rights in scientific discoveries and applied engineering, leading to the development of worldwide patent systems. The classes of invention protectable under the patent laws of the US, including the procedures in protecting inventions in the Patent Office and the courts. Reviews of past cases involving inventions and patents in (a) the chemical process industry and medical pharmaceutical, biological, and genetic-engineering fields; (b) devices in the mechanical, ocean exploration, civil, and/or aeronautical fields; (c) the electrical, computer, software, and electronic areas, including key radio, solid-state, computer and software inventions; and also (d) software protection afforded under copyright laws. Conducting periodic joint real-time class sessions and discussions by video-audio internet conferencing, with other universities. Enrollment limited.
R. H. Rines

Management in Engineering
(Offered under: 2.96, 6.930, 10.806, 16.653)
Prereq: None
U (Fall)
3-1-8
Introduction and overview of engineering management. Financial principles, management of innovation, technical strategy and best management practices. Case study method of instruction emphasizes participation in class discussion. Focus is on the development of individual skills and management tools. Restricted to juniors and seniors.
H. S. Marcus

Engineering Risk-Benefit Analysis
(Offered under: 1.155, 2.963, 3.577, 6.938, 10.816, 16.862, 22.82, ESD.72)
Prereq: Calculus II (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit
Emphasis on three methodologies pertaining to decision making in the presence of uncertainty: reliability and probabilistic risk assessment (RPRA), decision analysis (DA), and cost-benefit analysis (CBA). Risks of particular interest are those associated with large engineering projects such as the development of new products; the building, maintenance and operation of nuclear reactors and space systems. Presents and interprets some of the frameworks helpful for balancing risks and benefits in the situations that typically involve human safety, potential environmental effects, and large financial and technological uncertainties. Review of elementary probability theory and statistics included.
G. E. Apostolakis

Engineering Systems Analysis for Design
(Offered under: 1.146, 3.56, 16.861, ESD.71)
Prereq: 1.145J or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject ESD.71.
R. de Neufville

Applications of Technology in Energy and the Environment
(Offered under: 1.149, 2.63, 5.00, 10.579, 22.813, ESD.174)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduces advanced undergraduates or graduate students in the Schools of Engineering and Science to the integration of technical, economic, political, and environmental consideration required for the successful implementation of new technology. Case studies are drawn from the energy and environment sectors with some emphasis on analytic techniques that serve as a “tool box” for students. Technologies considered include fossil, nuclear, solar, wind, fuel cell and energy conservation. International aspects, such as weapons proliferation and global climate effects, also discussed. Enrollment limited.
J. Deutch, R. Lester

UPOP Summer Practice Experience
(Offered under: 1.149, 2.63, 6.901, 10.579)
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-1-0 [P/D/F]
Can be repeated for credit
Immerses engineering sophomores in the world of professional engineering experience by providing guided instruction in all aspects of the job acquisition process. Students complete a 10–12 week internship assignment during the summer, which includes maintaining a structured journal of observations and experiences, meeting with UPOP staff members, writing essays, and completing a self-evaluation. May be repeated twice for credit; spring term can be taken only in conjunction with fall term.
S. Luperfoy

UPOP Reflective Learning Experience
(Offered under: 1.149, 2.EPR, 3.EPR, 6.EPR, 10.EPR, 16.EPR, 22.EPR)
Prereq: 2.EPW or permission of instructor
U (Fall)
0-0-3 [P/D/F]
Reflective learning experiences for engineering juniors that serve as the culmination of their sophomore year in the UPOP program. Students review their internship experiences through written and oral presentations and receive small-group and individualized coaching to reinforce the cognitive link between all aspects of the UPOP experience and their disciplinary field of study.
S. Luperfoy

Innovation Teams
(Same subject as 15.371)
Prereq: Permission of instructor
G (Fall, Spring)
4-4-4
Students work in teams to develop commercialization strategies for innovative research projects generated in MIT laboratories. Projects cover critical aspects of commercialization, from selecting the target application and market for the technology to developing an intellectual property strategy and performing a competitive analysis. Instruction provided in communication and teamwork skills, as well as analysis of the
challenges and benefits of technology transfer. Includes lectures, guest speakers, and extensive team coaching. Designed primarily for students in engineering, science, and management. Applications, resumes, and a brief statement of interest are required prior to registration.

*F. Murray, L. Perez-Breva*

**Introduction to Modeling and Simulation**
(Offered under: 1.021, 3.021, 10.333, 22.00)
Prereq: 18.03, 3.016, or permission of instructor
U (Spring)
4-0-8 REST

Basic concepts of computer modeling and simulation in science and engineering. Uses techniques and software for simulation, data analysis and visualization. Continuum, mesoscale, atomistic and quantum methods used to study fundamental and applied problems in physics, chemistry, materials science, mechanics, engineering, and biology. Examples drawn from the disciplines above are used to understand or characterize complex structures and materials, and complement experimental observations.

*M. Buehler, N. Marzari, R. Radovitzky, T. Thonhauser*